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CONTENTS

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Guest Editorial

IMMUNOLOGY AND NOBEL PRIZE : A LOVE STORY

Several breakthroughs revealing the way in which our bodies protect us against microscopic threats of almost any description have been duly acknowledged by the Nobel Prizes in Physiology or Medicine. Interestingly, Nobel Prizes in Physiology or Medicine including the latest one, for the year 2011, has been awarded for twelve times to the field of Immunology.

The story began in 1901 with the very first Nobel Prize in Physiology or Medicine - it was awarded to ***Emil Von Behring*** for his pioneering work which resulted in the discovery of antitoxins, later termed as antibodies. Working with Shibasaburo Kitasato, Von Behring found that when animals were injected with tiny doses of weakened forms of tetanus or diphtheria bacteria, their blood extracts contained chemicals released in response, which rendered the pathogens' toxins harmless. Naming these chemical agents 'antitoxins', Von Behring and Erich Wernicke showed that transferring antitoxin-containing blood serum into animals infected with the fully virulent versions of diphtheria bacteria cured the recipients of any symptoms, and prevented death. This was found to be true for humans also; and thus Von Behring's method of treatment – passive serum therapy – became an essential remedy for diphtheria, saving many thousands of lives every year.

Shortly after this, the very first explanation about the mechanisms of immune system's functioning was proposed which paved way for extensive research in immunology till today. ***Paul Ehrlich*** had hit upon the key concept of how antibodies seek and neutralize the toxic actions of bacteria, while ***Ilya Mechnikov*** had discovered that certain body cells could destroy pathogens by simply engulfing or "eating" them. Ehrlich imagined the cell to be surrounded by protruding antibody side-chains which could break off and circulate in blood stream and bind in a highly specific manner to the poisons secreted by bacteria. Mechnikov coined the term 'phagocytosis' and the special cells as 'phagocytes' which were deployed by the host to capture and destroy harmful bacteria. We now know that the incredibly complex immune system mounts attacks in both of these ways. It was entirely fitting, therefore, that Ilya Mechnikov and Paul Ehrlich shared the 1908 Nobel Prize in Physiology or Medicine in recognition of their work on immunity.

By that time it was also well recognised that the immune system is *not always* protective and there was evidence that it could damage the body. Understanding how the immune system can be prompted to behave in a self-

destructive manner led to the discovery of anaphylaxis by ***Charles Richet*** for which he received the Nobel Prize in Physiology or Medicine 1913. Charles Richet demonstrated that dogs that had received an injection of sea-anemone poison without any noticeable distress always went into shock and died quickly after receiving a weaker dose a set amount of days later. Instead of raising tolerance towards the toxin, as was generally expected, the initial dose in fact made animals highly sensitive for a set period of time to even miniscule amounts of the poison. This opened up another facet of immune systems' complexity of action and regulation.

The fact that there were other players in the immune systems' orchestra was brought to the focus by ***Jules Bordet*** who revealed that the antibodies recruit a special type of protein to deliver the lethal blow for which he received the 1919 Nobel Prize in Physiology or Medicine. Antibodies created and released into the blood stream to specifically attack bacteria required the presence of a heat-sensitive substance always present in blood, which was initially named 'alexin', and later given the more appropriate name of 'complement'. Taking advantage of the specific way in which complement proteins bind to antibodies, Bordet also developed the Complement-fixation test, which became an invaluable tool for detection of syphilis.

There were many more unresolved questions, probably attributable to immune system and the major one was the uncertainties of blood transfusion; while a few cases of blood transfusion were successful and many more were unsuccessful. This was partially solved by ***Karl Landsteiner*** who discovered that the transfusion reactions occurred when a recipient possessed natural antibodies against a donor's blood cells and proposed the existence of human blood groups. Accordingly people were classified into A, B, O or AB blood group systems based on the presence of antigens and this discovery made blood transfusions not only more safe but also more scientifically based and predictable. In recognition of this major contribution, the 1930 Nobel Prize in Physiology or Medicine was awarded to Karl Landsteiner.

There was still the intriguing question of detection and discrimination of self from foreign antigens by the immune system, and this also coincided with the longest gap between any two successive Nobel prizes in the field of immunology. ***Frank MacFarlane Burnet*** and ***Peter Medawar*** showed how the immune system selectively recognizes and destroys foreign agents but prevents any attack on cells and tissues of the host itself. Finally, the 1960 Nobel Prize in Physiology or Medicine was awarded to them for revealing how self-discrimination is learned at the biological level. Immunological tolerance is a gradual learning process throughout embryonic life, in which the immune system is exposed to some form of self-defining molecules that are present on the host's cells.

A long-standing question in the field was how an almost identical-looking collection of antibody proteins can, at the same time, have the capacity to target specifically any one of an almost infinite range of foreign agents – until their structure was solved by the recipients of 1972 Nobel Prize in Physiology or Medicine. ***Gerald Edelman*** and ***Rodney Porter***'s methods yielded

different perspectives of the general antibody structure, which were later combined to provide a more definitive image of antibody specificity and further refined the understanding of the mechanisms of the immune system.

Meanwhile the scene of action was shifting to the molecular and genetic levels and the1980 Nobel Prize in Physiology or Medicine rewarded the achievements of ***Baruj Benacerraf, Jean Dausset*** and ***George D Snell*** for the identification of Major Histocompatibility Complex (MHC). MHC proteins, collectively known as histocompatibility antigens, are unique to each individual. The role played by MHC proteins in immune functions, as well as, in organ transplantations and susceptibility to many diseases was gradually discovered over the years to the present state.

Niels K Jerne described how the immune response is exquisitely controlled, and was built on his premise that antibodies can themselves act as antigens. With the various sets of antibodies stimulating or suppressing the production of each other, he visualized the immune system as a self-regulating network that can switch itself on and off in response to a foreign invasion. ***Georges J F Köhler*** and ***César Milstein*** independently created long living cell lines that could generate large amounts of a particular antibody. Combining their technique, monoclonal antibodies could be synthesised which has led to many medical and biochemical applications. The three scientists were awarded the1984 Nobel Prize in Physiology or Medicine for their seminal contributions.

Susumu Tonegawa, the 1987 award prize winner explained how the gene components can rearrange and shuffle together to form huge number of combinations coding for millions of antibodies. Uncovering this mechanism for antibody diversity revealed that genes are not fixed but can rearrange within the life of an individual and explained how a limited genetic material is used intelligently by the immune system to produce antibodies practically to an unlimited number of different antigens.

All these days the major focus of research and development in immunology was related to humoral immunity. Developments in understanding of the cell mediated immunity was rather slow, but significant. This culminated in the Nobel Prize in Physiology or Medicine 1996 being awarded to ***Peter C. Doherty*** and ***Rolf M. Zinkernagel*** for investigating how the T killer lymphocytes kill selectively the virus infected cells. Simultaneous developments in explaining the role cellular immunity were broadening the scope of this system not only in fighting external threats, but were also explaining the threats by malignant transformations of cells and how these are dealt with by the immune system.

Three scientists won the Nobel Prize in Physiology or Medicine 2011 for their discoveries about the immune system that opened up new avenues for the treatment and prevention of infectious illnesses and cancer. American ***Bruce A Beutler*** and French scientist ***Jules A Hoffmann*** shared the award with Canadian-born ***Ralph M Steinman***. Bruce Beutler and Jules Hoffmann were cited for their discoveries in the 1990s of receptor proteins that can recognise bacteria and other microorganisms

as they enter into the body, and activate the first line of defence in the immune system, known as innate immunity. Ralph Steinman was honoured for the discovery of dendritic cells, which help regulate adaptive immunity, the next stage of the immune system's response, when the invading microorganisms are purged from the body.

Cells of the innate immune system sense host invasion by detecting structural determinants that are broadly conserved among pathogens of a given phylogenetic group. Hoffmann studied in Drosophila (fruit fly) how these structural determinants could be identified to initiate an innate immune response in the host. This insect has no adaptive immune response but is highly resistant to microbial infection. Flies infected with microbes secrete antimicrobial peptides from fat body (equivalent to mammalian liver) that limits the infection.

The receptor mediating the production of antibacterial peptides against fungal and gram positive bacterial infections is Toll protein. Toll protein is a transmembrane receptor with an extracellular domain and an intracytoplasmic region. The microbial components do not bind directly to Toll protein; instead Toll activation is mediated by a distinct proteolytic cascade due to infection resulting in formation of Speatzle. The Toll protein activation by Speatzle leads to a series of signalling cascade resulting in nuclear factor kappa B (NF kB) activation and transcription of several hundreds of genes. Prominent among these genes are those encoding the antifungal peptides, Drosomycin and Metchnikowin. Hoffmann identified that toll deficient Drosophila when infected with fungi failed to produce Drosomycin and succumbed to fungal infection. Though both fungal and gram positive bacteria act upon Toll protein, the extracellular pathways resulting in formation of Spaetzle are different. The Toll-dependent defence against gram positive bacterial infection is mediated through Peptidoglycan receptor protein SA (PGR-SA).

The response to gram negative bacterial infection involves Toll-independent mechanisms and the sensing involves structurally distinct molecules – the peptidoglycan-recognition proteins (PGRPs) and the gram-negative binding proteins (GNBPs/ beta PGRPs). This is linked to Imd pathway which results in activation of I kappa B Kinase (IKK) complex and RELISH, culminating in NF kB and transcription of genes encoding antibacterial peptides, Diptericin, Cecropins, Drosocin and Attacin resulting in defence against these bacteria. Both Toll dependent and Toll independent mechanisms ultimately converge and help in the protection against a wide variety of microbes.

While Hoffmann described innate immunity in Drosophila, Beutler studied innate immunity in mouse models. Bruce Beutler and Anthony Cerami discovered that the substance that induces cachexia and was previously named as 'cachectin' is tumour necrosis factor (TNF). TNF is a cytokine, able to induce fever and inflammation as protective response and sepsis or shock as an exaggerated response.

A prototype inducer of innate immune response is lipopolysaccharide (LPS), an endotoxin released by gram negative bacteria. Sensing LPS is very important to overcome gram negative infections and cytokines (especially TNF) produced by mononuclear phagocytes in response to LPS orchestrate the immune response. An

exaggerated response following LPS detection leads to endotoxic shock.

Interested in the mechanism by which LPS activates mammalian immune cells, Beutler used TNF production as a phenotypic endpoint to identify the LPS receptor. Macrophages were of primary importance in the recognition of LPS. Identification of the receptor hinged on the positional cloning of the mammalian LPS locus, which had been known since the 1960s as a key genetic determinant of all biological responses to LPS. In1998, Beutler's lab identified the mammalian LPS receptor as Toll- like receptor-4 (TLR-4) by genetically mapping and cloning a mutant allele form that was unresponsive to LPS in mice. In contrast to Drosophila where there is no direct contact between the Toll protein and the microbial pathogen, the situation is apparently different in mammals, in which TLR-4 is clearly in direct interface with the microbial world.

Subsequently, with efforts from many other laboratories, 12 mouse TLRs and 10 human TLRs were discovered which can detect signature molecules that herald infection (including LPS, lipopeptides, flagellin, unmethylated DNA, dsDNA, ssRNA). TLRs were thus called as gatekeepers of the most powerful inflammatory responses. Beutler thereafter continued to apply a forward genetic approach to identify the genes that are essential for the innate immune response in mammals. In this process, germ-line mutations that alter immune functions were created through a random process using the alkylating agent N-ethyl-N-nitrosourea (ENU), detected by their phenotypic effects, and then isolated by positional cloning. His work disclosed numerous essential signalling molecules required for the innate immune response and helped to delineate the biochemistry of innate immunity. The ENU mutagenesis effort now underway in the Beutler laboratory is the largest in the world, and presently the only one primarily devoted to the decipherment of innate immunity.

Ralph Steinman's discovery of dendritic cells bridged the adaptive immunity discovered by Ehrlich to innate immunity discovered by Mechnikov. His work contributed immensely to the development of vaccines and the study of autoimmunity. His interest on how the specific immune cell or lymphocyte is selected from the diverse immune system for a particular antigen led him to the discovery of dendritic cell (DC) 35 years ago and he spent the subsequent years elucidating its functions.

Lymphocytes alone were not sufficient and some accessory cells were required to produce specific immune response. This accessory cell was thought to be nothing but a macrophage initially, later on proved to be the dendritic cell by Steinman. 1974 Nobel Prize winning work of George Palade and Christian De Duve helped Steinman in identification and purification of dendritic cell. He put forward that these cells were distinct from macrophages based on the fact that they had multiple projections, had no membrane enzymes, lacked lysosomes, had poor viability, detached easily from cell cultures and lacked key receptors for phagocytosis.

His initial attempt to prove that DC is in fact a different cell with respect to its role in adaptive immune response (Mixed Leucocyte Reaction) was taken with scepticism by immunologists who believed macrophages had the key role as antigen presenting cells. In 1982, Steinman with his colleagues could localise mouse DCs with

monoclonal antibodies.

He proposed that DC captures the antigen and presents it to the T cells, which in turn expand to form Killer cells or Helper cells, also inducing B cell response. There was real breakthrough when DCs could be removed from lymphoid organs or could be generated from progenitors ex vivo and then loaded with appropriate antigen to be re-infused back into the organism for inducing antiviral or antitumor activity. This formed the basis for immunotherapy against cancer. Steinman had tried this technique on himself to fight against cancer.

The next target set by Steinman and his colleagues was to localise the DCs in the human body. These cells were found to be at interface of the body with the environment like skin, airway and other epithelia, also in lymphoid organs where DCs interact with the T cells.

Another important function of DCs discovered was that these cells in steady state capture self or harmless antigens and silence the immune system, either by clonal deletion, anergy or expanding regulatory T cells. Subsequently during infection, DCs channelize the response of T cells only against the pathogen, not on any self antigens. With infection, DCs mature and select the specific T cell from the body's pool of millions of lymphocytes. Thus the DCs were called as the conductors of immune orchestra with its multiple roles.

Inspired by Pasteur, Steinman harnessed the knowledge of DCs to develop vaccines. The vaccine trials were conducted successfully in mice for various diseases like Tuberculosis, Type I Diabetes, HIV, melanoma and allergy. The phase I clinical trials in humans are under way. This definitely has opened up a bright future in research in immunology and its clinical applications for the treatment of not only infections, but also of many non-infectious diseases with an immunological basis. It is indeed a special Nobel Prize for immunology this time but unfortunately Mr. Steinman was not alive to personally receive a richly deserved accolade.

Research in Immunology has had a rich past and present with a long standing love affair with Nobel Prizes and there can be hardly any doubt that the future would be any different, but only better.

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MODERATE REGULAR EXERCISES REDUCE INFLAMMATORY RESPONSE FOR PHYSICAL STRESS

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Abstract : Exercises induce pro-inflammatory cytokines. We assessed the effect of different grades of exercises on inflammatory cytokine response. Twenty healthy volunteers performed a single bout of moderate exercise, a single bout of strenuous exercise and one month regular moderate exercise using standardized 10m Shuttle Walk Test. Interleukin-6 (IL-6) and Tumour Necrosis Factor Alpha (TNF-∝) were estimated by Sandwich ELISA method after each exercise regime. Statistics were run using SPSS software version 11.0, Systat software. Repeated measures ANOVA has been used for analysis of IL-6 values and Friedman test has been used for analyzing TNF-∝ and IL-6 values. Twenty healthy volunteers (18 to 30 years) were chosen for this study. The mean and SEM of plasma levels (pg/ml) of IL-6 before exercise was 10.70±1.11 pg/ml, whereas, after acute moderate exercise and acute strenuous exercise it was 12.00±1.09 pg/ml and 13.35±0.89 pg/ml respectively. Interestingly, after one month of moderate exercise the values decreased to; 8.80±0.65 pg/ml. Mean and SEM of TNF-α before exercise was 121.78±29.06 pg/ml. With acute moderate exercise and after acute strenuous exercise the values were 132.90±35.75 pg/ml and 112.05±29.89 pg/ml respectively. After one month moderate exercise the levels decreased to 94.95±27.29 pg/ml. The observed changes in both IL-6 and TNF-α levels before and after both moderate and strenuous exercise were statistically significant. Although there was a slight decrease in the value of both the cytokines after one month of regular moderate exercise compared to baseline value, the difference in the values was not statistically significant. However, both IL-6 and TNF-∝ levels showed overall statistically significant difference among the different grades of exercise. Plasma IL-6 and TNF-∝ increase with acute moderate exercise and IL-6 increases further with acute strenuous exercise. Their levels tend to fall below baseline with one month of regular moderate exercise indicating that regular moderate exercise has beneficial effects.

Key words : interleukin-6 tumour necrosis factor alpha exercise

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INTRODUCTION

Increased levels of TNF-α and IL-6 have often been demonstrated to be one of the predictors of increased risk for development of lifestyle diseases such as hypertension, coronary artery disease and diabetes mellitus. Exercises of moderate nature have been shown to reduce the incidence of cardiovascular diseases (1). Regular exercise improves the health and stabilizes the immune system (1-6). Many diseases have been recently attributed to persisting inflammation. During the last two decades, several studies have been carried out to monitor the changes in cytokine levels with different grades of exercises. There have been studies on subjects undertaking marathon running, military training, downhill running on a treadmill, cycling, etc., on different groups of individuals in different parts of the world (7-10). The observations of these studies are not uniform. Most of them indicate rise in the levels of inflammatory cytokines following burst of exercise of varying levels. The reports of relationships between the cytokines IL-6 and TNF-α are variable (11, 12). There are studies which indicate that high end athletic activities do increase infections as well as cardiovascular mortality (13-15). The issue that still remains to be addressed is what level of exercise will help in the overall improvement of the general health. Which of these responses is the best for maintenance of a good immune status ?

The impact of exercise on various cytokines has been described differently in different studies. These variations have been attributed to different exercise regimen, pre-existing competition-stress, as well different patterns of exercises and different applications of statistics and methods. We undertook this study to understand the influence of a single bout of moderate exercise and a single bout of strenuous exercise on the plasma levels of TNF-α and IL-6 and compare them with the levels at the end of one month of moderate exercise in healthy individuals leading a sedentary life.

METHODS

Subjects

20 healthy volunteers, not performing any kind of regular exercise were included in the study after obtaining their consent. Institutional ethics committee of M.S. Ramaiah Medical College, Bangalore, approved the study. The subjects were excluded if they had any allergic disease, chronic viral infections like HIV, Hepatitis B and C, chronic metabolic diseases like diabetes and hypothyroidism. Individuals with hypertension were also excluded

Exercise regimen

All subjects were made to perform a single bout of moderate exercise (acute moderate exercise), a single bout of strenuous exercise (acute strenuous exercise) and a scheduled moderate exercise regime everyday for one month. The subjects were made to perform acute moderate exercise on the first day and acute strenuous exercise on the second day. They were made to perform scheduled regular moderate exercise from third day onwards, for 30 days with strict monitoring. The exercise was graded as moderate or strenuous based on the rise in heart rate. It was labelled as moderate

when the heart rate increased by 50% from resting level and was labelled as strenuous when heart rate doubled (16-18). Heart rate was also used for grading exercise on a daily basis as measuring the heart rate is simple, in-expensive and reliable. Heart rate was estimated by using the standard Heart Rate Monitor Machine (HRM) from Polar Company (RS-100). It was worn on the wrist of the subjects like a watch as specified in the manual.

Shuttle walk test protocol

The exercise regime chosen was the standardized 10 m Shuttle Walking test regime, described by Glenfield Hospital, Leicester, United Kingdom in collaboration with the department of Physical Education and Sports Science, Loughborough University of Technology, United Kingdom (19-22). In this exercise protocol, the subjects walk on a 10 m plain path at the 2 ends of which are placed marker cones. The subjects walk between the cones corresponding to the beeps given out by a record player. Subjects have to increase their speed of walking gradually according to the shortening of intervals between the consecutive beeps as time progresses. The aim of the study was to look into the effect of a moderate exercise.

Analysis of samples

A venous blood sample from cubital vein (using vacutainers) was collected just before acute moderate exercise (baseline). Another sample was collected immediately after acute moderate exercise on the same day. After performance of acute strenuous exercise on the next day, the sample was collected again. Blood sample was also collected from individuals after one month of scheduled regular moderate exercise on the last day after the exercise. All the samples were obtained between 1 pm and 2 pm. The samples collected from each individual were aliquoted and stored at –40°C till further analysis. The plasma sample was used to estimate the levels of cytokines IL-6 and TNF-∝, by using the ELISA method. ELISA was performed using DuoSet ELISA development system as per the manufacturer's instructions (R & D systems, USA). Briefly, polystyrene microtiter plates (NUNC, U16 Maxisorp type, Denmark) were coated with monoclonal capture antibody (antihuman TNF-alpha antihuman IL-6) obtained from mouse (R & D systems, USA) and incubated at 4°C overnight. The following day, the plates were blocked and then incubated for 2 hours with plasma. This was followed by addition of corresponding biotinylated detection antibody obtained from goat (R & D systems, USA) and incubated for 2 hours. Subsequently strepatavidin horseradish peroxidase (R & D systems, USA) and tetra methyl benzidine substrate (Bangalore Genie, India) were added. The reaction was stopped using 2 N sulphuric acid and optical density (O.D) readings were recorded 450 nm (ELISA reader: Organon Teknika Microwell system, Reader 230s, Germany). All the experiments were conducted in duplicates. A standard curve was obtained based on the standards provided by the manufacturer. The results were expressed as concentration of cytokines (in pg/ml) read from the standard curve.

RESULTS

Twenty healthy volunteers in the age group 18 to 30 (Mean and SD: 21.05±2.37)

were selected for the study. There were 11 males and 9 females. The demographic details of the subjects are as follows: For males; height: 1.68±0.07m, weight: 55±3.2 kgs, BMI: 20.2±1.2. For females: height: 1.58±0.06m, weight: 55.4±3.5 kgs, BMI: 22.43±1.5. IL-6 and TNF-∝ levels were measured before and after different grades of exercises. There was a significant rise in the levels of both IL-6 and TNF-∝ with both acute moderate and acute strenuous exercise when compared with the respective levels before the exercise (baseline value). There was a slight decrease in the levels of these two cytokines after one month of regular moderate exercise which was not significant (Table – Ia and IIa).

Percentage of subjects whose IL-6 levels increased from baseline is 60.0% after Moderate exercise and 60.0% after strenuous exercise, while this percentage was 20.0% after one month of moderate exercise which is statistically significant at p=0.019. Similarly, the percentage of subjects whose IL-6 levels decreased from baseline was 35.0% after moderate exercise and 35.0% after strenuous exercise, while it was 70.0% after one month moderate exercise at p=0.060, which may be considered close to statistical significance. (Ref: Table – Ib). Percentage of subjects whose TNF-a levels increased from baseline was 63.2% after moderate exercise and was 52.6% after strenuous exercise, while it was 15.8% after one month moderate exercise with p=0.007 which is statistically significant. Further, Percentage of subjects whose TNF-a levels decreased from baseline was 36.8% after moderate exercise and 47.4% after strenuous exercise, while it was 73.7% after one month

TABLE Ia : Effect of graded Exercise on IL6.

IL-6 levels Concentration in pg/ml (n=20)	*Range*	*Mean±SEM*
No Exercise	4.00–20.0	10.70±1.11[a]
Moderate Exercise	4.00–22.0	12.00±1.09[b]
Strenuous Exercise	5.00–20.0	13.35±0.89[bc]
One month moderate Exercise	4.00–13.0	8.80±0.65[d]
Significance	ANOVA Repeated measures, F=6.305 p=0.001	

Non-identical superscripts are significant at 5% level of significant by paired student t test while the identical superscripts are non-significant.

TABLE Ib : Number and percentage of subjects having improved, decreased and remained same in IL-6 after receiving graded level of exercise (n=20).

Changes in IL6	*After moderate exercise*	*After strenuous exercise*	*After one month moderate exercise*
Number of subjects increased in IL6 from baseline :	12 (60.0%)	12 (60.0%)	4 (20.0%)
Number of subjects decreased in IL6 from baseline :	7 (35.0%)	7 (35.0%)	14 (70.0%)
Number of subjects remained same from baseline :	1 (5.0%)	1 (5.0%)	2 (10.0%)

TABLE IIa : Effect of graded exercise on TNF-α levels.

TNF-α levels (pg/ml)	*Range*	*Mean±SEM*
No-Exercise	5.00–425.00	121.78±29.06[a]
Moderate exercise	4.00–620.00	132.90±35.75[b]
Strenuous exercise	4.00–520.00	112.05±29.89[abc]
One month moderate exercise	5.00–425.00	94.95±27.29[ad]
Significance[#]	Repeated Measures ANOVA F=7.011 p=0.006**	

Non-identical superscripts are significant at 5% level of significant by paired student t test while the identical superscripts are non-significant. Significance tests were carried out after natural log transformation.

TABLE IIb : Number and percentage of subjects having improved, decreased and remained same in TNF-α after receiving graded level of exercise (n=19*).

Changes in IL6	*After moderate exercise*	*After strenuous exercise*	*After one month moderate exercise*
Number of subjects increased in TNF-α from baseline :	12 (63.2%)	10 (52.6%)	3 (15.8%)
Number of subjects decreased in TNF-α from baseline :	7 (36.8%)	9 (47.4%)	14 (73.7%)
Number of subjects remained same from baseline :	–	–	2 (10.5%)

*One subject value of parameter is not obtained.

moderate exercise with p=0.060 which is also appears to be close to statistical significance (Table IIb). Significance test by paired proportion test was estimated using the significance test available online, developed by Prof Hossien Ashram, University of Baltimore, USA.

DISCUSSION

We observed that in both moderate and strenuous exercises, there were significant elevations in both IL-6 and TNF-α level, in unaccustomed normal subjects (Table – Ia and Table – IIa). The elevation of IL-6 was in equal percentage of subjects in response to moderate and strenuous exercise, while the number of subjects with increase in TNF-α decreased from 12 to 10 when they performed strenuous exercise. On performing continued moderate exercises for a month, the number of subjects whose levels of TNF-α as well as IL-6 decreased significantly compared to the initial baseline value (Table – Ib and Table – IIb).

The finding of triggered inflammatory cytokine production concurs with many previous publications (1-6). The exercise being used here is of moderate to severe grade and not of exhaustive nature as in our previous publication. This explains the elevated levels of TNF-α in the majority of subjects in the present study compared to the drop in the majority of non-athletes as published earlier (30). Even in the current study, there was a drop in 10% of subjects who had an elevation in TNF-α on strenuous exercise.

Gradual drop in inflammatory cytokines as well as in inflammatory markers on continued exercise practice has been demonstrated in few of the published studies especially in patients with coronary artery disease (24). This study shows a fall in IL-6 and TNF-∝ levels with regular moderate exercise, suggesting that such a decrease in the levels of these two cytokines could also be beneficial for health and immunity. It is of interest to draw the attention to our previous publication on the direct correlation of serum glucose and TNF-a levels (25). IL-6 and TNF-∝ are pro inflammatory cytokines, therefore then: overproduction leads to inflammation and tissue damage (26). Thus regular moderate exercise seems to optimise their release and thus may bring down deleterious effects of IL-6 and TNF-∝ by keeping them at levels necessary for human body with a buffer to elevate the level during sudden bursts of exercises. However, such a down regulation could also lead to increased susceptibility to some of the infections. This needs further clarification. But studies which have looked into cross sectional comparison of immunological status of athletes and non-athletes have not shown significant difference

in the susceptibility to infections (31). In a majority of the subjects, acute unaccustomed activity of moderate to mild nature was shown to elevate the pro-inflammatory cytokines. (7, 9, 25). However, this effect was not observed when healthy individuals were subjected to a strenuous exercise (30). Similarly, in the present study also (Table Ia and Table IIa), the level of TNF-α was decreased at the end of strenuous exercise and the level of IL-6 was found to decrease. The IL-6 under normal physiological circumstances inhibits TNF-∝ production, though initially both the cytokines are released from a similar source. This relationship of early drop in TNF-∝ with sustained rise in IL-6 appears to be a normal stress response for maintenance of homeostasis which is seen even in response to LPS (lipopolysaccharide) and probably reflects a physiological relationship. The effect of elevated inflammatory cytokine response seems to be attenuated in the majority of subjects, especially when they undergo regular training, but not totally ablated. Our previous studies have indicated attenuation of response but not total ablation of inflammatory response, if such individuals were to get involved in bouts of unaccustomed physical activity. This may be beneficial for sports persons and athletes who need to get involved in such sudden bouts of activity during competitions. Thus such people tolerate physical stress better. Mental stress is also known to increase plasma levels of cytokines IL-6 and TNF-∝ (27). In these individuals, the levels of these cytokines may not rise as much as it would increase in those not performing regular exercise, facing the same level of mental stress (28). Several studies have shown that in patients with atherosclerosis, Coronary Artery Disease and Diabetes Mellitus have elevated levels of IL-6 and TNF-∝ (27). Certain autoimmune disorders like Rheumatoid Arthritis are associated with increased plasma levels of pro inflammatory cytokines like IL-6 and TNF-∝, which increase joint inflammation (29). Regular moderate exercise may benefit such patients by bringing down the levels of such cytokines. What is surprising is the deviation or failure of the process that is observed in a small percentage of subjects. The reasons for such a failure need further evaluation. The level of moderate exercise to be prescribed to different individuals to achieve a stable immunological homeostasis needs to be worked out and we need to further investigate and ascertain how and by what mechanisms the levels of TNF-∝ and IL-6 alter in response to various degrees of exercises. The normal range of plasma levels of IL-6 and TNF-α are very wide. The levels for IL-6 and TNF alfa estimated in the current study are different from other populations in other studies as basal levels have not been established yet for the Indian population and hence it is not surprising that the values are different from the range suggested. Moreover, the levels of the pro-inflammatory cytokines are also altered due to psychological factors, like the amount of psychological stress the person undergoes just before starting an exercise. In this study, the volunteers are drawn from medical profession, undergraduates and postgraduate students, who are generally not used to physical exercise or physical stress. The cytokine levels obtained may also vary to an extent depending on the kits obtained from different companies. Variability is one of the major drawbacks in cytokine research. Some studies have pointed out to the fact that these cytokine levels are

highly variable (32, 33). However, since the values were measured using the same kit on the same set of individuals before and after exercises, the differences measured are reliable. The changes in the cytokine levels before and after intervention are more critical than the absolute values.

Hence performing moderate exercise on a daily basis not only has beneficial effects for health, but it also proves to be a buffer against physical stress.

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EFFECT OF SHORT DURATION AEROBIC EXERCISE TRAINING ON REFLECTION INDEX, STIFFNESS INDEX AND PULSE WAVE VELOCITY

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Abstract : The study was aimed to establish the effect of aerobic exercise on reflection index (RI), stiffness index (SI) and brachial finger pulse wave velocity (BFPWV) in healthy subjects of Bangalore, India. Students of 18 to 25 years (males) were recruited according to the inclusion criteria. The subjects were trained on treadmill for a period of 8 weeks, and the above parameters were measured using BIOPAC software and doppler machine. ANOVA of repeated measures was done to see the effect of training on RI, SI and BFPWV with bonferroni correction. There was a significant decrease in above parameters ($P < 0.0001$) compared to basal levels. There was significant correlation between BFPWV and SI ($P<0.001$). 8 weeks of training showed beneficial effect by reducing BFPWV, SI, and RI and it returned towards baseline after subsequent 4 weeks of detraining. We conclude that changes are because of the effect of aerobic exercise and are reversible.

Key words : arterial stiffness aerobic exercise BFPWV

INTRODUCTION

Arterial stiffness in simple terms describes the rigidity of arterial walls. There are several methods to assess the arterial stiffness example pulse wave velocity (PWV), reflection index (RI), stiffness index (SI), ultrasound derived indices and magnetic resonance imaging (MRI) derived indices (1). Vascular stiffness develops from a complex interaction between stable and dynamic changes involving structural and cellular elements of the vessel wall. These vascular alterations are influenced by heamodynamic forces as well by extrinsic factors such as hormones, salt and glucose regulation. Simple aging and common diseases like hypertension, diabetes mellitus will also amplify the vascular changes that results in arterial stiffness number of life style changes and therapies that can reduce arterial stiffness including weight loss, exercise, salt reduction, neuroendocrine directed therapies such as targeting the renin angiotensin aldosterone system, natriuretic peptides, insulin modulators (2). The non invasive

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assessment of cardiovascular function by means of the peripheral pulse has gained substantial interest in recent year. The peripheral pulse provides a signal that establishes the presence of a beating heart and quantifies the cardiac rhythm and its variability with time (3), (4). Peripheral arterial pulse wave forms are obtained by different variety of instruments for example photoplethysmography (PPG) (3), digital volume pulse (5), applanation tonometry or arterial ton meter (4, 6, 7, 8), fidelity micro manometer (Millers instrument) (9, 10).

The present study was aimed to see the effect of aerobic exercise on all the parameters of peripheral arterial stiffness like RI, SI and brachial finger pulse wave velocity (BFPWV).

METHODS

Subjects

Male subjects in the age group of 18-25 years were recruited from the student and staff population of St John's medical college and hospital Bangalore. A brief history, general and systemic examination was performed and healthy subjects were recruited according to the inclusion criteria. All the procedures were approved by the ethical committee of St John's medical college Bangalore. To the subjects detailed description of protocol was explained and written informed consent was obtained. Weight was measured using digital scale (OEHNLE-WAAGEN GmbH & CO, Murrhardt, Germany) and height was measured to the nearest 0.1 cm using stadiometer (Holtain limited, CRYMYCH, DYFED, made in Britain). Forearm length was measured from point of appearance of the brachial pulse through doppler and photo-plethysmograph sensor on the finger.

Preparation of volunteers and procedure

Subjects came early morning in the post absorptive state, entire procedure was explained to the volunteers to allay their apprehension. Then the subjects underwent moderate intensity aerobic exercise training for half an hour thrice weekly alternate day over a period of 8 weeks. Bruce 3rd grade of treadmill exercise (treadmill speed of 4.8 kph and inclination of 10 degree) was adopted. This 3rd grade of exercise corresponded to 55% to 69% of target heart rate (THR) which represents the moderate degree exercise. Continuous monitoring of heart rate was done during the treadmill exercise with the help of an instrument called Welch Allyn.

Determination of arterial stiffness

Finger photo pulse plethysmography, lead II ECG and doppler recording was done and the waves obtained were acquired by the BIOPAC PRO software. A pulse transducer was wrapped around the left index finger to record the finger pulse wave by photo pulse plethysmography. The pulse plethysmograph measures the density of blood in the fingertip. Doppler probe was used to record the left brachial artery wave. Both waves were recorded simultaneously for 5 minutes. This recording was done every 2 weeks during the training period and after 4 weeks of detraining.

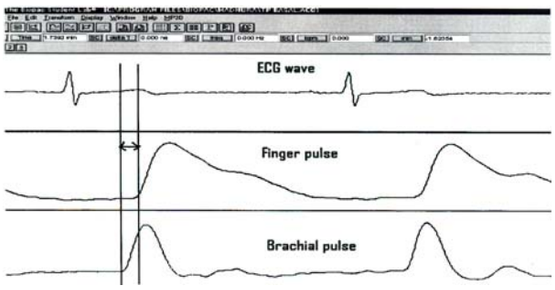

Fig. 1 : Recording of wave.

Calculation of RI, SI and BFPWV using pulse wave.

$$RI = \frac{\text{Amplitude of 2th peak (diastolic)}}{\text{Amplitude of 1st peak (systolic)}}$$

$$SI = \frac{\text{Height of the subject in meters (Ht)}}{\text{Time difference between the systolic and diastolic peak (PTT)}}$$

$$BFPWV = \frac{\text{Distance between the two points (finger tip to cubital fossa)}}{\text{Time interval between the foot points of finger pulse and pulse of the brachial artery } (\Delta T)}$$

RESULTS

The basal recordings of different parameters of 18 healthy male subjects are given in the Table I.

TABLE I : Subject characteristics (age group 18 to 25 years).

Variables	*Mean N=18*	*SD*
Age	20.44	±2.24
Height (meters)	1.70	±0.06
Weight (kgs)	61.49	±7.99
BMI	21.65	±2.22
SBP (mm Hg)	115.77	±4.46
DBF (mm Hg)	74.77	±5.16
HR (beats/min)	78.44	±4.79
RI (%)	62	±0.08
SI (m/s)	8.79	±0.68
BFPWV (m/s)	9.27	±0.36

TABLE II : Repeated measures ANOVA of different parameters at different time interval during the exercise training period including detraining period.

Variables	*Baseline*	*15 days*	*30 days*	*45 days*	*60 days*	*1 month detraining*	*P value*
RI	0.62(0.08)	0.60(0.05)	0.53(0.04)	0.48(0.04)	0.45(0.03)	0.50(0.06)	0.0001
SI	8.79(0.68)	8.15(0.45)	7.73(0.36)	7.40(0.37)	7.27(0.34)	7.70(0.56)	0.0001
BFPWV	9.27(0.36)	8.73(0.49)	8.10(0.43)	7.70(0.4)	7.51(0.35)	8.21(0.75)	0.0001

TABLE III : Repeated measures ANOVA of different parameters at different time interval during the exercise training period excluding detraining period with Bonferroni correction.

Variables	*Baseline*	*15 days*	*30 days*	*45 days*	*60 days*	*P value*
RI[1,2]	0.62(0.08)	0.60(0.05)	0.53(0.04)	0.48(0.04)	0.45(0.03)	0.0001
SI[1,2]	8.79(0.68)	8.15(0.45)	7.73(0.36)	7.40(0.37)	7.27(0.34)	0.0001
BFPWV[1,2]	9.27(0.36)	8.73(0.49)	8.10(0.43)	7.70(0.4)	7.51(0.35)	0.0001

-Values are Mean (S.D)
[1]Significant difference across 5 group using an ANOVA of repeated measures ($P<0.05$)
[2]Significantly different between the group's using a post-hoc Bonferroni-corrected pair-wise t-test

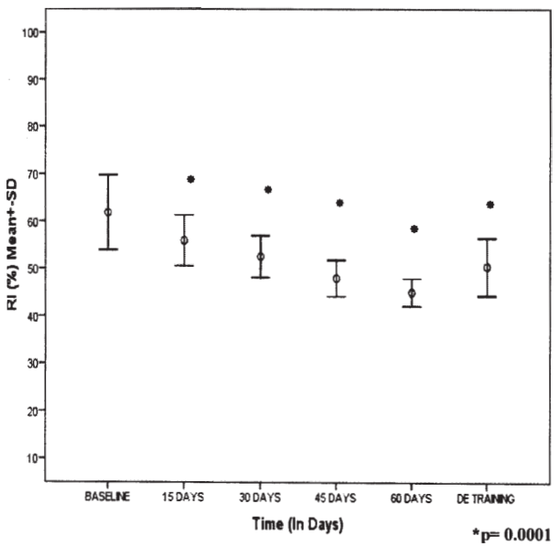

Fig. 2: Repeated measures ANOVA of RI.

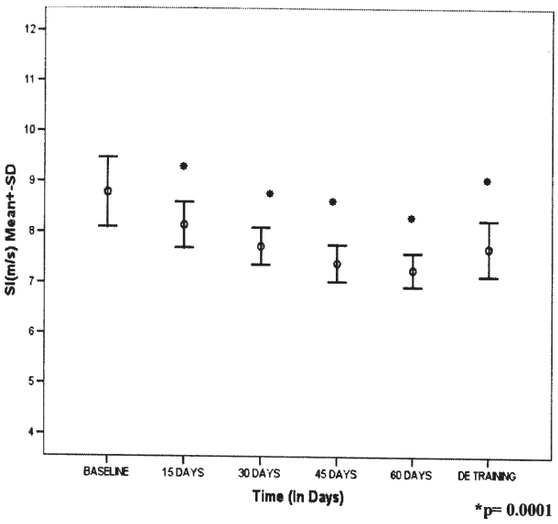

Fig. 3: Repeated measures ANOVA of SI.

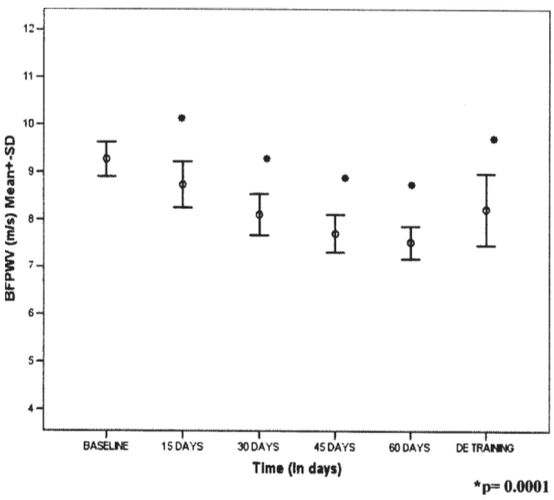

Fig. 4: Repeated measures ANOVA of BFPWV.

TABLE IV: Pearson Correlation between BFPWV and SI.

		Mean	*SD*	*Pearson correlation*	*P value*
Baseline	SI	8.79	.68	.38	0.116
	BFPWV	9.27	.36		
After 15 days	SI	8.15	.45	.32	0.196
	BFPWV	8.73	.49		
After 30 days	SI	7.73	.36	.55	†0.02
	BFPWV	8.10	.43		
After 45 days	SI	7.40	.37	.85	*0.00
	BFPWV	7.70	.40		
After 60 days	SI	7.27	.34	.86	*0.00
	BFPWV	7.51	.35		
1 month detraining	SI	7.70	.56	.79	*0.00
	BFPWV	8.21	.75		

DISCUSSION

The salient finding of our study was as follows: first, within one month of endurance training the BFPWV and SI significantly reduced indicating that arterial compliance increased which in our study we measured

by brachial artery doppler waveform and finger pulse plethysmography. BFPWV measurements are comparable with those of aortic PWV or carotid femoral PWV (11) and brachial ankle PWV (BAPWV) (12).

Second, the increase in arterial compliance which was significant starting from 4 weeks of training ($P<0.0001$) continued till 8 weeks with a significant increase ($P<0.0001$). Arterial compliance is reflected by the decrease in BFPWV. There is significant correlation between BFPWV and stiffness index ($P<0.001$), our results are consistent with other study. (13) Third, the increase arterial compliance showed a trend to reverse at the end of one month after detraining, indicating a return to the baseline values a few months after cessation of endurance training. This confirms that the change in the arterial compliance was as a result of endurance training (14).

Study by Hayashi et al have shown that aerobic exercise training has more beneficial effect in the central artery by way of reducing stiffness as compared to the peripheral artery, nevertheless reduced compliance is seen in both types of arteries (6). The mechanism would be the increased production of NO (nitric oxide) during and also immediately after the exercise due to shear stress, but with repeated stimulation through regular exercise NO release remain elevated during the period between the exercise bouts and leads to vasodilatation. The study done by Kingwell et al demonstrated that lower limb exercise increased the upper limb blood flow. This suggests that stimulus is not related to local muscular adaptation but it is due to enhanced basal production of NO during the period between the exercise bouts (15). Regular exercise prevents and restores the age related decline in endothelial dependent vasodilatation. Endothelium is important for regulation of vascular tone and cardiovascular homeostasis. To see the affect of regular aerobic exercise study was done by De Souza C A et al in healthy young men, middle and older age group who were either sedentary or exercise trained individuals (tread mill exercise using Balkes protocol for 3 months). Forearm blood flow (FBF) was measured in all of them. Among the sedentary men FBF response to acetylcholine was 25% lower in middle and older age group compared to young group, in contrast, there was no age related difference in the vasodilatory response to acetylcholine among the endurance trained men (16). The elements of the arterial wall that determine its compliance are the composition of elastin and collagen (structural determinants) and the vasoconstrictor tone exerted by its smooth muscle cells (functional determinant). Because biochemical changes in the elastin-collagen composition of the arterial wall are believed to occur over years, it is unlikely that short-term regular aerobic exercise increased arterial compliance by this mechanism. However, it is possible that the increased pulse pressures and mechanical distension during the exercise sessions “stretched” collagen fibers and modified their cross-linking, thereby increasing arterial compliance. In this context, it is possible that regular exercise increased arterial compliance by reducing the chronic suppressive influence exerted by sympathetic-adrenergic tone either directly or by enhancing the sympathoinhibitory effect of NO(17). The vascular benefits of exercise are indirectly related to a decline in the release of neuro hormonal vasoconstrictors and reduced efferent sympathetic tone, and to endothelial mechanical signaling associated with increased pulsatile flow and stretch and

consequent enhanced nitric oxide stimulation (18). By finding the indices like RI, SI and BFPWV we can easily identify the peripheral arterial stiffness, which helps in identifying the early cardiovascular diseases and we can advice the patients for the regular aerobic exercise training as it reduces the arterial stiffness and also reduces the incidence of cardiovascular diseases.

Conclusion

Moderate intensity aerobic exercise training has its effects on arterial compliance both in central and peripheral arteries. The reduced arterial stiffness would definitely decrease the incidence of cardiovascular diseases in a given population and at the peripheral level reduce and prevent micro vascular damage.

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EJECTION FRACTION AT THE FIRST ATTACK OF MYOCARDIAL INFARCTION AND POSTINFARCTION SURVIVAL IN SOUTH INDIAN POPULATION

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Abstract : Ischemic heart disease is estimated to be the most important cause of mortality by the end of 2020 world wide despite sufficient improvement in health care. It has several modifiable and few non modifiable prognostic variables. Therefore, we analyzed the data of all patients admitted for the first time for acute myocardial infarction (MI) and evaluated the long term modifiable prognostic variables retrospectively. We did not find any difference in the age, blood pressure, hematological and several biochemical parameters between patients who survived and those who expired in 4 years of follow up. Our study revealed that in the expired group patients, the mean admission heart rate, ejection fraction, serum urea and creatinine levels were higher and bicarbonate level was lower compared to survived group patients at the first attack of MI. Also, despite the less incidence of myocardial infarction in females, the percentage of cardiac death was higher in female MI patients. We suggest from our retrospective analysis that MI patients with higher heart rate, altered renal function and metabolic acidosis should be rigorously followed up and special counseling should be provided to old age female patients for better prognosis and survival.

Key words : myocardial infarction, ejection fraction, acidosis, female patients

INTRODUCTION

Myocardial infarction (MI) is the one of the commonest causes of morbidity and mortality in men and women worldwide (1, 2). MI is so common in developing countries such as India, by 2007 32% death were due to ischemic heart disease (IHD) alone (3). In India it has become the leading cause of death (4). Although a new epidemic, it has become a major health issue and mortality burden is expected to double by 2015 (5). According to the mortality estimate in Tamilnadu itself IHD related death is 36% (6). It is associated with few non modifiable (7) and several modifiable risk factors (7, 8,

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9). A drastic rise in the stressful yet sedentary life style, food intake rich in high energy and fat, smoking, lack of physical activities leading to obesity has led to the sharp rise in incidence of cases even in developing countries (10). Despite sufficient improvement in health care, ischemic heart disease is estimated to be the most important cause of mortality by the end of 2020 world wide (2).

The patients who survive the first attack of acute myocardial infarction are susceptible to heart failure, recurrence of angina, re-infarction, arrhythmias, and sudden cardiac death. Most deaths occur in the first six months after infarction (10). Advancing age is the most important non-modifiable prognostic factor for long-term prognosis (11) whereas the left ventricular function assessed clinically or quantified as either ejection fraction or end-systolic volume is the most important modifiable factor (10).

An ejection fraction less than 30% is reported to be a major risk factor for cardiac death and re-infarction, in the first year after myocardial infarction (12). Apart from ejection fraction, there are several other modifiable prognostic factors such as decreased heart rate variability, cigarette smoking, hypercholesterolemia, and diabetes mellitus etc. in a Spanish report it was found that the admission plasma glucose and first fasting blood glucose levels can predict the adverse outcome of acute coronary syndrome patients (13). Similarly, a report from Netherlands suggests that an impaired baseline renal function can add to the prognostic risk after first myocardial infarction (14). Similar works done in and Canada and USA showed that serum urea and creatinine levels are powerful indicators of post discharge mortality especially among the old aged cardiovascular patients and patients with systolic dysfunction respectively (15, 16). So, identification of these adverse prognostic factors can help in risk stratification and further modification of treatment regimen (1). However, similar reports on the predictive value of various biochemical or hematological parameters on cardio vascular mortality and survival after first attack of MI are missing in Indian studies.

Therefore, we wanted to assess the long-term (from 2006 to 2009) prognostic variables of cardiac death in MI cases. Hence, we retrospectively analyzed the recorded data (the biochemical and hematological parameters and cardiac markers at the time of admission) of MI patients admitted to Pondicherry Institute of Medical Sciences (PIMS) from 2006 to 2009.

MATERIALS AND METHODS

The cardiac marker enzymes, biochemical and hematological parameters of forty six MI cases admitted to PIMS from the period of 2006 to 2009 were collected. MI was confirmed based on their clinical features, ECG recordings and cardiac marker enzymes. The physiological parameters at the time of admission such as age, heart rate, systolic and diastolic blood pressures and respiratory rate were also noted down.

All biochemical parameters were estimated in the clinical biochemistry lab using commercial kits adapted to autoanalyser. Glucose estimation was by glucose oxidase peroxidase method (Enzopak;

Reckon Diagnostics, India), and Troponin I estimation was by rapid sensitive immunochemistry method (Biomed, India). The cardiac enzymes used as markers of MI such as total CK, CK-MB and LDH were assessed by kits from Enzopak (Reckon Diagnostics, India). Lipid profile parameters such as total cholesterol, triglyceride and HDL cholesterol were analyzed by using kits from Siemens (Siemens; Siemens Health Care Diagnostics Inc. USA). Sodium, potassium and chloride were assessed in a semi automated electrolyte analyzer (Ilyte, India). Total cell count, hemoglobin and packed cell volume were analyzed using commercial kits (Transasia, India) adapted to automated coulter (Sysmex XT 1800i, USA). ESR was evaluated by Wintrobe's method. RBC, platelet count, MCV, MCH and MCHC were determined from peripheral smear. PT-INR was evaluated using commercial kits (Tulip diagnostics, India).

Statistical analysis of data

The data are expressed as Mean±SD. Comparison between the two groups was done by Student's *t* test for parametric data and by Mann Whitney test for non-parametric data. Correlation between parameters was done by Pearson's correlation analysis. The p values less than 0.05 was considered significant.

RESULTS

The patients were divided into two groups. The first group was survived group consisting of patients who survived till 2009 and expired group consisted of patients who did not survive. The physiological parameters and ejection fractions are depicted in Table I while biochemical and hematological parameters are shown in Table II and III respectively.

The gender ratio showed that the male gender was predominant in survived group while percentage of female gender was more in the expired group. There was no difference in the admission age. There was no difference in the systolic and diastolic blood pressures and respiratory rate (Table I). However the admission heart rate was significantly higher in the expired group. Also the severity of myocardial dysfunction as assessed by the ejection fraction in ECHO was significantly higher in the expired group (Table I).

Admission values of urea (P<0.01) and creatinine (P<0.05) were significantly higher in the survived group. There was no difference in any other biochemical parameters and cardiac enzymes among the

TABLE I: Physiological parameters at the time of first admission of old MI patients: comparison of patients who survived versus who expired within 3 years of first attack.

	Survived (n=26)	*Expired (n=20)*
Females	6/26(23%)	7/17(41%)
Males	20/26(77%)	10/17(59%)
Age (Years)	57.34±13.05	64.05±7.24
HR (per min)	80.69±12.17	96.44±20.30**
SBP (mm Hg)	128.91±18.51	122.00±23.75
DBP (mm Hg)	81.00±11.06	75.46±16.46
Respiratory rate (per minute)	28.75±5.96	28.42±11.63
EF (%)	49.16±9.00	35.62±8.45*

Data presented as mean±SD. Analysis done by student's unpaired *t* test. *P<0.05 and **P<0.01; HR: heart rate; SBP: systolic blood pressure; DBP: diastolic blood pressure; EF: ejection fraction.

TABLE II: Cardiac markers, enzymes and lipid profile at the time of first admission for old MI patients: comparison of patients who survived versus who expired within 3 years of first attack.

	Survived (n=26)	*Expired (n=20)*
FBS(mg/dL)	133.60±40.39	161.00±62.64
Urea (mg/dL)	29.64±17.63	63.21±44.68**
Creatinine (mg/dL)	1.34±0.77	2.29±1.80**
Troponin I positive (> 1 ng/mL)	12/26(46%)	7/17(41%)
CK (U/L)	233.10±160.00	551.77±312.49
CKMB (U/L)	68.35±35.31	97.27±57.74
LDH (U/L)	264.33±106.61	324.33±119.7
TC (mg/dL)	182.70±56.84	179.42±42.14
TG (mg/dL)	152.70±46.21	109.20±34.62
HDL (mg/dL)	36.60±6.22	34.80±6.83
LDL (mg/dL)	112.70±53.38	118.00±24.70
VLDL (mg/dL)	27.88±4.80	22.00±7.07
Na^+ (mM/L)	136.66±3.81	136.26±6.61
K^+ (mM/L)	4.21±0.58	4.76±1.19
Cl^- (mM/L)	101.23±6.12	100.88±7.37
$HCO3^-$(mM/L)	24.89±4.48	20.50±4.48*

Data presented as Mean±SD. *P<0.05 when analysis done by student's unpaired *t* test and ##P<0.01 when analysis done by Mann Whitney non parametric test.

TABLE III: Hematological parameters at the time of first admission for MI patients in survived and expired groups.

	Survived (n=26)	*Expired (n=20)*
Hb (g/dL)	12.39±3.52	11.33±2.87
PCV (%)	34.80±14.82	25.28±15.23
ESR (mm/1 hr)	50.10±8.73	104.66±16.00
PT-INR	1.40±0.34	1.10±0.14
RBC (millions/mm^3)	4.60±0.62	3.98±0.80
Platelet (lakhs/mm^3)	2.80±0.63	2.46±1.17
MCV (fL)	90.03±4.46	88.15±8.26
MCH (pg)	30.50±2.27	29.90±1.14
MCHC (g/dL)	34.00±1.86	34.05±2.59

Data presented as Mean+SD. Analysis done by student's unpaired *t* test.

2 groups (Table II). Also there was no difference in any of the hematological parameters (Table III). The ejection fraction was positively correlated with platelet count in the expired group of patients (Table IV).

TABLE IV: Correlation of ejection fraction (EF) of MI patients in survived group and expired group with platelet count and heart rate (HR).

	Survived group		*Expired group*	
	r	*P*	*r*	*p*
Platelet count	–0.94	0.067	–0.773	0.024
HR	–0.06	0.870	0.685	0.09

P<0.05 was considered significant.

DISCUSSION

In our study we found the admission age of survived group to be higher. However, this difference was not statistically significant. This could be due to a small sample size. Male gender is recognized as a risk factor for coronary artery disease below the age of 45 (17). In our study also the male cases were predominant in the survived group with an incidence of 77% and females were only 23%. However, it was surprising to note that the female gender percentage increased (41%) in the expired group. As the mean age for both the groups was higher than 45 yrs, the risk of MI is same for both the gender. Nevertheless, the increased percentage of female patients in expired group suggests that either female gender are more susceptible to cardiac death from re-infarction or they are paid less attention in our society in terms of health care especially in the old age in India.

The admission fasting blood sugar level was more than 126 mg/dl for both the groups. However, there was no statistical difference between the groups. DM is already an

established risk of MI (18). However, in our previous study we had reported an increased fraction of non diabetic and pre diabetic patients in MI cases in our area (19). Acute MI is an extremely stressful situation. So it is associated with release of higher level of stress hormones such as cortisol, catecholamines which have insulin antagonistic action can increase the blood glucose level. This could be the reason why the admission glucose value was higher in both the groups. It has been reported that among the non-diabetic patients with acute myocardial infarction, those with higher admission blood glucose had higher rates of death, re-hospitalization for heart failure, and re-hospitalization for non-fatal re-infarction (20). Hence, the importance of detection of higher admission value of plasma glucose should be taken seriously for a better prognosis during the subsequent period of follow up.

The percentage of troponin I positive case was almost equal in both the groups. There was no difference in the levels of CK, CK-MB and LDH. However, the severity of myocardial dysfunction as assessed by the ejection fraction in ECHO was significantly lower in the patients of expired group suggesting that gross reduction in left ventricular function at the time of admission itself is an indicator of poor prognosis. Previous reports suggest EF less than 0.3 which would be roughly 30% to be a risk factor for cardiac death and re-infarction (12), and in our study it was within the range of 27% to 43% in the expired group.

There was no difference in the admission lipid profile and electrolyte values. Conversely, the admission values of urea ($P<0.01$) and creatinine ($P<0.05$) were significantly higher in the survived group. There was no difference in any of the hematological parameters (Table III). This suggests that cardiac dysfunction was mostly accelerated in the expired group of patients due to early deterioration of their renal functions.

Despite the absence of difference in hematological parameters, there was a significantly negative correlation between the ejection fraction and platelet count in the expired group (Table IV). This correlation was not significant in the survived group. It is a well known fact that platelets play an important role in thrombosis as well as in acute ischemic coronary syndrome (17). In a previous report low platelet count was found to be associated with MI and peripheral artery disease patients (18). In contrast we found platelet count to be within the normal range in both the groups of our study. Despite this platelet count was negatively correlated with their left ventricular dysfunction (EF). To the best of our knowledge, this has not been reported earlier. An earlier report suggests increased platelet reactivity to be associated with poor prognosis in the MI survivors (19). It indicates that MI patients with higher platelet count and MI patients with normal platelet count but higher platelet reactivity also would be vulnerable to left ventricular dysfunction which just might be the case in our patients' group. Unfortunately there was no assay done on platelet reactivity in these patients so we do not have any direct data supporting our observation.

The mean bicarbonate value was lower in expired patients group compared to

survived patients (Table III). The base deficit indicates that patients in the expired group had metabolic acidosis at the time of their first attack of MI. Previous reports suggest that the lack of tissue perfusion and increased oxygen demand in MI leads to lactic acidosis and more often it is associated with cardiogenic shock. Severe acidosis itself can lead to ventricular arrhythmias (20). Acidosis per se can worsen fibrin polymerization and further strengthens the clot (21). Normally acidosis initiates hyperventilation to expel the excess acid as carbon dioxide in these MI patients as a compensatory mechanism. The patients who fail to expel the acids out by such physiological compensatory mechanisms would go through a prolonged period of metabolic acidosis which further can aggravate their condition.

From our study, we conclude that in Indian population, those MI patients whose admission values are associated with low ejection fraction, high platelet count or high platelet reactivity and acid base imbalance indicating acidosis are more vulnerable to cardiac death. Even when they survive the first attack of MI they have to be monitored more aggressively as part of their follow up. Also we propose that the old aged Indian female MI patients are more susceptible to cardiac death compared to male patients. Hence special attention and counseling should be provided to them and their family members to ensure better prognosis and a prolonged life span.

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A STUDY ON QUALITY OF LIFE IN PATIENTS FOLLOWING MYOCARDIAL INFARCTION

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Abstract : Subjective well being has been widely researched in the past few decades and in practical terms it is a term that encompasses the various ways people evaluate their lives including concepts such as life satisfaction, work and health etc. Since, it is well known, that psychological factors including stress, anxiety, poor sleeping habits etc are known to be important causes of life style disorders like myocardial infraction, we started with the hypothesis that subjective well being of post acute MI patients must be poorer compared to normal subjects in the same age group. A comparative study between normal subjects and post acute myocardial infarction patients was undertaken to compare their subjective well being and current mental health status, at Safdarjung Hospital, New Delhi using standardized questionnaires. The results showed significantly higher negative affect like inadequate mental mastery over immediate environment, perceived ill health including disturbed sleep, deficiency in social contacts, and a general ill being about life in the MI group ($P<0.05$). Regarding the positive emotions, the normal subjects showed a higher general well being positive affect, higher transcedence and higher perception of social support. ($P<0.05$).

The GHQ also yielded significantly better sleeping habits, less anxiety, better perception of health and more satisfaction with life in the normal subjects compared to post acute MI patients. ($P<0.05$).

Key words : subjective well being, positive affect, happiness index, negative affect, transcendence, general health questionnaire

INTRODUCTION

In 1967 subjective well being (SWB) was defined by Wilson as a happy person who is young, healthy, well educated, well paid, extroverted, optimistic, worry-free, religious and married with high self esteem, job morale, modest aspirations of either sex and of a wide range of intelligence (1). The relation of intelligence to SWB is measured

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by the degree to which intelligent people excel in society (2). According to Diener et al (3, 4), quality of life is the most important variable in the domain of health and inventories for quality of life usually include subjective well being questions (4, 5). Regarding coronary heart disease, i.e. (CHD) which is known to be a lifestyle disorder, there are many studies that have found an association between negative emotions (6) as well as a lack of positive affect and CHD (7, 8, 9).

The GHQ (General Health Questionnaire) is a well established screening instrument for psychiatric disorders that measure psychological distress and has been found to predict coronary heart diseases prospectively (10, 11). By administering both the subjective well being questionnaire and the GHQ questionnaire we wanted to observe whether CHD is independently correlated with the happiness state and psychological distress of the individual. In the light of the above observations, the study discussed here was conducted on post acute first episode of myocardial infarction patients (n=50) compared with normal subjects. The hypothesis which was being tested was that subjective well being both positive & negative affects were different in young adults who have suffered a heart attack compared to their normal counterparts.

METHODS

Case control study was done in which 50 patients (posts acute myocardial infarction) and 50 normal patients in the same age group (30-55 yrs) were selected. All the subjects - post MI and normal were matched for sex (42 males & 8 females in each group). Before starting the study we took a clearance from the institutional ethical committee. The myocardial infarction patients were scored using the Framingham score (12) and low risk patients were selected for the study.

The subjective well being inventory developed by Nagpal and Sell for WHO (13) was used to measure the subjective well being of the subjects. The questionnaire contains 40 items which cover 11 factors describing various aspects of well being and ill being as perceived by the subjects. Factors 1-6 describe items addressing positive emotions and factors 7-11 address negative emotions. The total positive and negative scores as well as individual factors were compared between the normal and post MI group, $P<0.05$ being a significant difference.

The general health questionnaire (GHQ –28) is a measure of current mental health and since its development by Goldberg in the 1970s (10) it has been extensively used in different settings and different cultures. Each item is rated on a four point scale (less than usual, no more than usual, rather more than usual or much more than usual). The GHQ–28 is a well known instrument for measuring minor psychological distress and gives an indication of mental health and quality of life, $P<0.05$ being a significant difference.

The ICMR index of emotional well being questions were used to compare the percentage time of happiness between normal and post MI patients (Statistical significance at $P<0.05$) (14). Happiness is one of the components of subjective well being and is considered more of a personality trait (15). All analysis was done using SPSS – 17 and

P values calculated at 95% confidence levels.

RESULTS

SUBI can be scored by attributing values 3, 2, 1 to response categories of the positive items and 1, 2 & 3 to the negative items. Fig 1 is showing mean scores for positive factors. The mean score for normal subjects is 28.78±4.979 and the mean score for post MI patients is 32.28±7.068. The maximum and minimum score in this category are 57 and 19 respectively. High scores (41-50) indicating low positivity is significantly higher in the post MI group (P<0.05 using Fischer exact test).

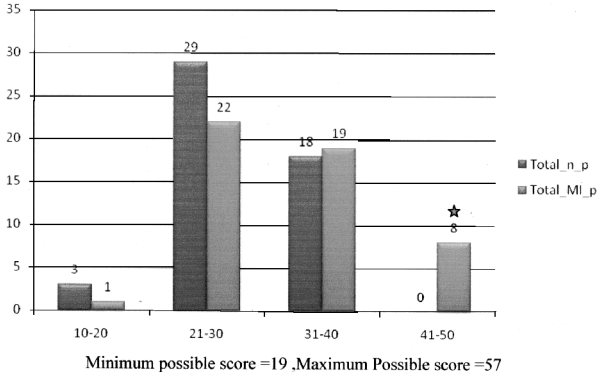

Fig. 1: Distribution of positive SUBI scores in Normal patients Mean = 28.78, N = 50 and MI patients Mean = 32.28, N = 50

Fig. 2 is showing mean scores for negative factors. The mean score for normal subjects in this group = 43.98±6.257 and the mean score for post MI patients in this group = 40.60±5.632. The maximum, and minimum scores in this category are 63 and 21 respectively. In the subgroup (31-40) which is a low score indicating high negativity is significantly higher in the post MI group (P<0.05) and vice versa for high scorers (51-60) (P<0.05). The GHQ-28 questionnaire was

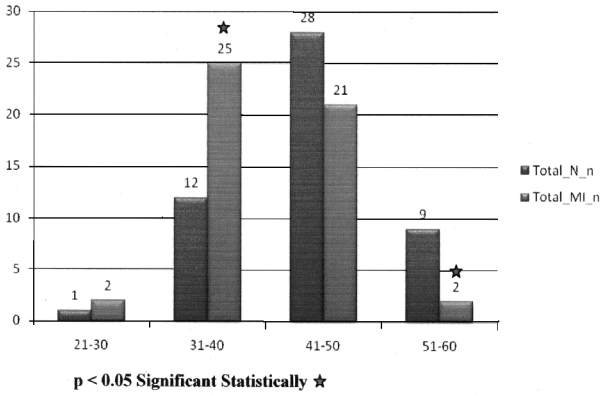

Fig. 2: Distribution of negative SUBI scores in Normal Subjects Mean = 43.98, N = 50 and MI patients Mean = 40.60, N = 50.

used to evaluate distress state of the patient and distress may be correlated with distress due to major illness. There are four main components of the GHQ with each component having 7 items. These 4 components are A) health general well being (positive affect) B) anxiety and sleep C) satisfaction with life D) negative self worth. All the components were compared between the control and post MI subjects.

Table I shows the general characteristics of the subjects. All the post MI subjects were interviewed 6 weeks post MI and Framingham scores were < 10%. Framingham scores were

TABLE I: General characteristics of subjects.

Variables	*Normal Subject (n=50)*	*MI Patients (n=50)*	*P value*
	Mean±SD		
Age, yr	40.71±7.61	47.42±7.21	0.01*
Height (cm)	161.760±5.42	162.51±6.667	0.53
Weight (kg)	61.50±9.22	65.34±11.247	0.06
Monthly income (in Rs)	17,891±9290.92	11,625±7097.71	0.02*

calculated based on age, total cholesterol, HDL cholesterol, systolic BP, diastolic BP, diabetes and smoking (12). The mean age of post MI patients was significantly higher than in normal patients (P<0.05) and monthly income was significantly higher in the normal group (P<0.05). The mean weight and height of subjects in both the groups were comparable.

Table II shows the comparison of positive and negative factors between normal and MI patients (there is a negative correlation between the scores vis-a vis these factors). Amongst the positive factors, Factor 1, factor 4 and factor 6 are showing significant difference between the 2 groups. While studying the negative factors, almost all the factors namely factor 8, 9, 10 and 11 are showing a significant difference between the two groups.

Results of General Health Questionnaire (GHQ)

TABLE II: Comparison of positive and negative factors between normal and MI patients.

	Normal (N=50)	*Ml (N=50)*	*P value*
General Well Being (positive effect)	5.08±1.32	6.40±1.44	0.0001*
Expectation-Achievement congruence	5.78±1.30	6.02±1.52	0.360
Confidence in copying with difficult situations	4.78±1.33	5.18±1.39	0.170
Transcendence	4.48±1.46	5.10±1.76	0.053*
Family group support	4.08±1.07	4.10±1.47	0.933
Social support	4.58±1.37	5.48±2.06	0.014*
Family life	2.84±0.99	2.82±0.87	0.925
Inadequate mental mastery	11.78±2.38	10.66±2.78	0.028*
Perceived ill health	14.92±3.03	12.38±2.78	0.0003*
Deficiency in social contacts	6.66±2.01	7.98±1.29	0.0002*
General Well Being-Negative affect	7.78±1.34	6.76±1.78	0.001*

TABLE III: Current mental state given by Goldberg General Health Questionnaire GHQ-28).

	Normal (N=50)	*Ml (N=50)*	*P value*
Health	9.96±2.32	12.43±4.05	0.001*
Anxiety & Sleep	9.12±3.35	11.10±5.25	0.011*
Satisfaction with life	12.08±3.25	15.14±3.99	0.0001*
Negative self worth	8.00±2.16	8.96±3.85	0.127

TABLE IV: Comparison of percent time (ICMR index of happiness).

	Normal (N=50)	*Ml (N=50)*	*P value*
Happy	64.60±11.82	57.90±17.84	0.032*
Neutral	14.00±11.07	188.50±19.75	0.118
Unhappy	21.40±14.57	30.80±21.63	0.009*

*P<0.05 – Statistically significant.

A 28 item GHQ was administered to the 2 groups and the results compared by using unpaired student t test. P<0.05, being considered a significant difference at 95% confidence interval. The 28 items have been further subdivided into 4 major sections as follows :

(A) Health (B) Anxiety & Sleep (C) Satisfaction with life (D) Negative self worth (transcendence)

49 subjects were interviewed in each group - normal and post acute MI. They were essentially the same group which was interviewed for SUBI. Lower scores indicate the following (A) Better perception of health, (B) Less anxious & less worried about lack of sleep (C) Better satisfaction with life and (D) Less negative self worth.

The sections A, B & C are showing a significantly lower score i.e. a significant

difference in the normal subjects compared to the MI group ($P<0.05$). In the section D there is no significant difference between the two groups. The GHQ results show a better mental state in normal patients compared to the MI group.

Results of ICMR Emotional Well Being Questionnaire

50 subjects in each group - normal and post MI were interviewed about the percentage of time that they felt happy, neutral or unhappy. The subjects selected were the same as were interviewed for SUBI scores. Results showed that the mean percentage time that persons were happy was significantly higher in the normal subjects ($P<0.05$). As a natural corollary the mean percentage of time that people were unhappy was significantly higher in the post MI patients ($P<0.05$).

DISCUSSION

Subjective well being has been reported as a composite measure of independent feelings about a variety of life concerns, in addition to general well being and ill being. Lot of research findings have suggested a moderate and robust relationship between self rated health and subjective well being. Physician assessed health has a less robust relationship (16). Further, the relation between health & subjective well being is conditioned by age and is stronger for measures of negative than positive affect.

Two sets of mechanisms could theoretically mediate the relationship between affective states and physical health. Firstly positive well being might be associated with favorable health habits and prudent lifestyles. The second possibility is that associations are mediated through psychological processes, defined as the pathways by which psychosocial factors stimulate biological systems, through CNS activation of autonomic, neuro endocrine, inflammatory and immune responses (9, 11, 17, 18).

Researchers have indicated that positive affective states are related to favorable profiles of functioning in several biological systems and may thereby be relevant to risk of development of physical illness, especially in men (9, 11). Starting in 1982, a brain storming exercise was begun with the aim of establishing hypothetical areas which may reflect or be conducive to well being and/or ill being. The exercise led to a consensus on eight areas of common possibly related to or parts of well and ill being. These were subjective will being positive affect, subjective well being negative affect, mental mastery over self and environment, rootedness and belongingness, structural and cohesive aspects of family life, density of social network, security in crises (socio economic and related to health) and expectation-achievement harmony. The finding that well being and ill being are distinct but uncorrelated confirm earlier research findings (Headey et at, 1983). Our findings on the negative factors (SWB) have shown that significantly higher negative affective states are associated with patients after MI compared to normal subjects. These findings are corroborated by many studies (19). Which have shown that negative affective states such as depression are associated with increased risk of coronary heart disease. The first scientific quote about the brain

affecting the heart and emotion triggered cardiovascular changes leading to heart disease dates back 4 centuries to William Harvey in 1628. Stress factors may contribute to hard CHD end points because of alteration of autonomic nervous system functions (20). The findings of our study regarding the positive affects like general positive affect, transcendence (spirituality) and social support showed a significant difference in the normal subjects ($P<0.05$). Researchers like Davidson et al (15) have found that positive affect protected against the development of coronary heart disease while depressive symptoms increased the likelihood of disease onset. They also point out that positive affect can easily be assessed by measures such as whether or not the patient smiles during the clinical interview and whether they appear to take pleasure or excitement in aspects of their daily life. These are certain aspects which have been assessed by us both in the SUBI inventory as well as in the ICMR emotional well being inventory. Happiness levels have been shown to be significantly higher in the normal subjects ($P<0.05$). Many researchers feel that positive affect may have an indirect effect on CVD, perhaps by modifying the effects of stress and this stress reduction may decrease CVD risk (15, 21). Section B of GHQ which consisted of sleep related questions indicated better sleep patterns in normal subjects ($P<0.05$) (22).

To further validate the findings of the above questionnaire, we administered two more questionnaires to the same study and control group. ICMR index of emotional well being and mental health (modified) and General Health Questionnaire (28 items form). The ICMR index of emotional well being and mental health is a validated questionnaire tested on Indian populations. The percentage of time when the person feels happy, neutral and sad has been calculated by questioning all the individuals. Further our findings on factor 6 (social support) which shows a significantly higher ($P<0.05$) perception of social support in the normal subjects is supported by researchers who have reported that a strong and supportive social network is associated with increased happiness and a sense of well being (23). Lastly, our findings show a significantly lower current medical complaints, lower sleep and anxiety related problems and higher satisfaction with life in the normal group as derived by the GHQ. This finding is corroborated by Mark Hammer et al who have also showed an association between psychological distress and CVD (24). There have been studies using GHQ which has shown that post MI patients show significantly more somatic problems, anxiety and depression in some cases (25). Confounding factors like simultaneous occurrence of mental disorders like depression, history of recent tragedy in the family etc have not been taken into account which may contribute to happiness levels. A higher monthly income in the normal group and higher weight in the post MI group may have also contributed to better quality of life in the normal group. Keeping all this in proper perspective we have planned to undertake lifestyle and health behaviour interventions in MI patients in the young age group and assess the changes in subjective well being scores if any.

Quality of life is determined by various factors like life satisfaction, subjective well being, positive psychology and positive

mental health. All these factors and personality traits are measured by the subjective well being inventory. Our findings have shown significantly higher levels of general well being (positive affect), transcendence and social support ($P<0.05$) in the normal group compared with the post MI group. Regarding negative emotions there was significantly higher levels of inadequate mental mastery, perceived ill health, deficiency in social contacts and general well being (negative affect) ($P<0.05$) in the post MI group. The GHQ questionnaire covers the current mental status of the individual and psychological distress if any. This is also one of the components of quality of life. Our findings have shown significantly higher levels of concern about health, sleep and satisfaction with life in the post MI group. The ICMR index of happiness has also shown significantly higher percent time spent feeling happy in the normal group compared to the post MI group ($P<0.05$). 3 sets of questionnaires were used to get a complete picture of quality of life parameters.

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ASSESSMENT OF CARDIOVASCULAR RESPONSE TO TREADMILL EXERCISE IN NORMAL HEALTHY INDIAN ADOLESCENTS

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The study aims to assess the cardiovascular response to treadmill exercise test in healthy Indian adolescents. A group of 50 healthy adolescents took part in the study. Cardiovascular response was assessed by using treadmill exercise test as per Bruce protocol. Pulse rate, blood pressure and ECG were recorded before, during and after undertaking the treadmill test. Mean age and body mass index (BMI) were 18.7±0.51 yrs. and 21.4±3.44 kg/m^2 respectively. Karl Pearson Correlation analysis showed highly significant negative correlation between BMI and exercise time ($r = –0.598$, $P<0.001$) and between resting DBP and Exercise Time ($r = –0.424$, $P<0.002$). While BMI and DBP showed highly significant positive correlation ($r = 0.463$, $P<0.001$). During exercise pulse and SBP rose and DBP fell. SBP rose from mean 122 to 175 (rise by 53 mm of Hg) and DBP fell from mean 78 to 65 (fall by 13 mm of Hg). One min recovery pulse was 156 indicating 22% fall from target heart rate. All the parameters returned to near resting value at 6 min recovery. In 30% students DBP showed exaggerated response i.e. rise during exercise. These students had more BMI and higher resting DBP as compared to other students, which could be the reason for exaggerated response in these participants. In ECG there were no significant ST/T changes during exercise or recovery period. This study provides normal data for small sample of healthy Indian adolescents when subjected to treadmill exercise test.

adolescents body mass index
treadmill exercise test heart rate systolic blood pressure
diastolic blood pressure ECG

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INTRODUCTION

Dynamic exercise is often used to evaluate the functions of cardiovascular system, and the treadmill test is a commonly used dynamic exercise protocol. The study aims to assess the cardiovascular response to treadmill exercise in healthy adolescents, and create normal reference values of exercise testing in Indian adolescents. SBP, DBP and ECG changes during exercise and recovery period were studied. We also aimed to find out correlation between anthropometric factors and exercise response.

Treadmill test is a commonly used well established and diagnostic as well as prognostic tool for assessing patients with suspected or known coronary artery disease (1). Treadmill is a reliable, easily repeatable, noninvasive test and does not cause any harm to the patients. It helps to evaluate the level of functional capacity of cardio respiratory system in healthy individuals as well. In young population it can be used as screening test for participation in vocational, leisure and sport activities and also to observe the arterial pressure response to exercise. Arterial BP is used to indirectly assess heart's inotropic response to physical exertion associated with the level of exercise tolerance.(2) The hypertensive response of BP to physical exertion in normotensive individuals may be predictive of development of arterial hypertension later in future life, which can be prevented by changes in food habits, lifestyles etc. Hypertension is a key risk factor for cardiovascular disease morbidity and mortality. Several studies have examined the role of BP response to exercise as a risk factor for the development of hypertension (3).

During period of transition from adolescents to adulthood many structural, hormonal, and biochemical changes in body physiology take place. Hence it is necessary to establish reference values for this population, for the classification of physical fitness, and also for advice on exercise. It has been observed recently that maximal exercise capacity in children has deteriorated during past 20 yrs. BMI was found to correlate negatively and intense sports participation positively, with exercise time (4). It is documented that ethnic differences are important determinants of cardiopulmonary function. Applying adequate reference values is essential for the correct interpretation of the data from functional tests.

In view of these observations aim of the present study was to determine reference values for contemporary healthy Indian adolescents by using Bruce treadmill protocol.

MATERIALS AND METHODS

Selection of participants

^{2}).

Tread mill test

$_2$ administration, Emergency drugs, Ambu bag, Defibrillator etc. were kept ready. Participants were asked to lie down in supine position for at least 10 min before the exercise. Resting heart rate, SBP and DBP were recorded. For recording BP manual mercury sphygmomanometer was used. After skin preparation, ten disposable silver chloride electrodes were attached at proper position for continuous monitoring of electrocardiogram (ECG). Resting 12 lead ECG was recorded. Treadmill exercise was explained and demonstrated to the participant, especially regarding most comfortable gait and safety devices. They were instructed not to tightly hold the side rails to avoid isometric element. Heart rate and ECG were recorded continuously during exercise. SBP and DBP were measured at the end of every stage manually by mercury manometer. End point of the test was achievement of target heart rate (220 - age in yrs = 200/min)(1) or the test was planned

Statistical methods

$_2$ respectively. Mean resting SBP and DBP was 122.68±8.34 and 78.6±6.2 mm of Hg respectively. Average time of exercise was 9.7±2.04 min.

Table I shows Karl Pearson Correlation regression analysis. It showed highly significant correlation between BMI and resting BP. There was negative correlation between BMI and exercise time ($r = -0.598$, $P<0.001$) and between resting DBP and exercise time ($r = -0.424$, $P<0.002$).

Cardiovascular responses in terms of changes in Pulse, SBP and DBP at rest, at

TABLE I : Correlation of BMI with Cardio-vascular parameters of the subjects.

Parameters	*r*	*P*
SBP	0.433	0.002**
DBP	0.463	0.001**
Exercise time	–0.598	0.000**
DBP and Exercise time	–0.424	0.002**

*Correlation is significant at 0.05 level (two-tailed)
**Correlation is significant at 0.01 level (two-tailed)

TABLE III : Groups according to decreased and increased DBP response during TMT.

	A (Fall in DBP) Mean±SD (n=35)	*B (Rise in DBP) Mean±SD (n=15)*	*P Value*
BMI	20.24±2.3	23.06±2.05	0.00**
DBP rest	77.43±5.95	81.33±6.03	0.04*
Ex. time	10.25±1.8	8.57±2.12	0.01*
DBP THR	70.51±6.35	88.53±6.69	0.00**
1 min Recovery HR	152±9.69	165.2±9.43	0.00**
% Recovery in HR	24±4.85	17.36±4.7	0.00**
DBP 6 min Recovery	70.51±6.35	81.03±5.93	0.01*

THR – Target Heart Rate.

BMI – Body mass index; HR-Heart Rate; DBP-Diastolic Blood Pressure.

Unpaired Student's t test: Significance was tested at P<0.05 (*) and P<0.001 (**).

TABLE II : Mean HR, SBP, DBP at rest, at different stages of TMT and during recovery period.

	N	*HR*	*SBP*	*DBP*
At Rest	50	84±11.5	122.68±8.34	78.6±6.18
Ex. Stage				
1	50	132.46±21.89	142.6±15.33	78.48±7.51
2	50	155.98±22.15	154.32±14.13	77.92±8.98
3	48	177.47±20.58	164.95±14.77	78.66±9.14
4	36	200.16±7.30	167.38±11.20	73.05±9.50
5	2	200	175.00±7.07	65±7.0
Recovery				
1 min	50	155.98±11.33		
3 min	50	114.68±17.27	149.36±14.36	80.80±5.36
6 min	50	105.16±13.55	130.00±11.68	78.20±5.83

BMI – Body mass index; HR – Heart Rate; DBP – Diastolic Blood Pressure; SBP – Systolic Blood Pressure.

^{2}.

After interrogation it was discovered that one of them did not have a sound sleep in night due to some family problems. In study conducted by Bhave et al in 1989 (5), 32% ie 8 out of 25 adolescents could go up to fifth stage. In study by Sung et al in 1999 (6), 58% reached 5th stage and 10 % could reach 6th stage. Mean ex. time was more i.e. 15.7±2.2 min in adolescent boys as compared to 9.7±2 in ours indicating less endurance. This difference could be due to recent changes in lifestyle, lack of physical exercise and change in feeding habits. Sung et al (6), Becker et al (2) reported positive correlation in BP and ht, wt. This study also showed that resting SBP and DBP significantly correlated with BMI.

The arterial pressure response to exercise in children and adolescents has been the focus of several studies in many countries. It has been confirmed that there are differences when diverse populations are compared. Some of these differences are attributed to the different methodologies and test protocols used. In most studies, children and adolescents were evaluated by means of multistage protocols, particularly the treadmill test developed by Bruce. Our findings regarding blood pressure were similar to those reported in medical

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PHYSIOLOGICAL TASTE THRESHOLD IN TYPE 1 DIABETES MELLITUS

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Abstract : The sense of taste is one of the important oral chemical senses that play a critical role in human life. The taste threshold increases by number of factors such as age, local and systemic disease like diabetes, consumption of alcohol, smoking. The aim of the present study was to assess the relationship between taste threshold in type 1 diabetics and non diabetics for four basic taste modalities (i.e. sweet, salt, sour and bitter). We studied 70 cases of type 1 diabetic and 70 non diabetics. The taste threshold was evaluated using 7 different serially half diluted concentrations of glucose (2.00 M–0.031 M), Nacl (1.00 M– 0.0156 M), citric acid (0.05 M–0.0007 M) and quinine sulphate (0.001 M–0.000015 M). A significant increase in taste threshold for sweet ($P<0.0001$), salt, sour and bitter ($P<0.001$) in type 1 diabetic was observed. We concluded that taste sensation was reduced in type 1 diabetics.

Key words : taste threshold type 1 diabetics non diabetics sweet salt sour bitter

INTRODUCTION

The sense of taste plays a critical role in the life and nutritional status of humans and other organisms. It can affect the health of the individual by altering the food preferences and food habit of the person.

Human taste perception may be categorized according to four well known and widely accepted taste qualities, sweet, salty, sour and bitter.

Taste disorders are common in the general population. Although these disorders can have a substantial impact on quality of life and may represent significant underlying disease, they are often overlooked by the medical community. The taste threshold increases by number of factors such as age, ethnic backgrounds, drugs, local and systemic disease, consumption of alcohol, smoking and tobacco chewing.

India is the host to the largest diabetic population in the world with an estimated 79.4 million people by 2030 (1). Diabetic patients appears to be especially prone to

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taste disorder, these disorders tend to appears during the course of disease (2, 3). However, the pathophysiology of taste disorders remains unclear in diabetes (4, 5). An association between taste impairment and diabetic neuropathies has been described (6) but remain disputed (7). In addition, drug used in type II (non insulin dependent) diabetes mellitus have been thought to impair taste threshold (8, 9). So we formulated the present study to compare the taste recognizing threshold in type 1 (insulin dependent) diabetic subjects and non diabetic subjects.

METHODS

Subject group consisted of 70 diagnosed cases of type 1 diabetics (38 males and 32 females) age range from 20–45 years attending diabetic clinic, department of Medicine, Government Medical College, Nagpur, and 70 age and weight matched non diabetic controls (40 males 30 females).

Inclusion criteria for diabetics :–

1) All type 1 diabetic subjects diagnosed at least one year prior to the study (8).
2) Subjects of IDDM (Type 1) with normal kidney function and without any obvious clinical evidence suggestive of metabolic complication of diabetes.

Inclusion criteria for Controls :–

1) Age and weight matched non diabetics subjects.
2) Having good dental hygiene and not subject to food allergies (10).

Exclusion criteria for diabetics and controls:–

1) Type 2 diabetes mellitus (8, 9).
2) Those who are on any prescribed medicine (10).
3) Smoking and alcoholics (10).
4) Hypertensive (10).
5) Pregnant and lactating women (10).

Precautions :

Following precautions were taken before starting the Experiment (11).

1) The subjects were asked not to smoke, eat or drink anything except water at least for one hour before the threshold measurements.
2) At the time of testing the entire procedure was explained to each subject.
3) Tests were carried out in the morning time between 8 to 11 am.

Taste stimuli : Stimulus representing the four classical basic tastes was included for tasting the recognition taste threshold for particular taste. Seven serial half dilutions of the stock concentration were made for each taste solution, by using deionised distilled water and used for experiment (12). The starting concentrations were glucose (2.00 M), sodium chloride (1.00 M), citric acid (0.05 M), and Quinine sulphate (0.001 M). The taste sensitivity for each solution was investigated as per Harris and Kalmus method assisted by forced choice and updown tracking procedure for better output and result (13). Subjects were given two or three drop of the solution of lowest concentration

on the dorsum of tongue to taste first and then tasted successive higher solution until a definite taste was identified. Distilled water was used in between two solutions for rinsing. Rinsing of mouth was repeated till the subject volunteer said that no taste of the previously tasted concentration lingers on. Accordingly the actual threshold concentration was determined and the bottle number noted. Standard sequence was followed for taste recognition threshold i.e. sweet first followed by salt, sour and bitter taste solution (14).

The statistical analysis was done by using Man Whitney 'U' test.

RESULTS

Taste recognition threshold for sweet taste (Table I):

It was observed that at 0.25 molar and lower concentration only twenty three diabetic subjects were able to recognize sweet taste properly while forty nine non diabetic subjects recognize it correctly. For higher concentration that is 0.5 molar and above, forty seven diabetic and twenty one non diabetic subjects recognized sweet taste properly. In general diabetic subjects were less sensitive than non diabetic subjects (P<0.0001) for sweet taste. Taste recognition threshold for salt taste (Table II):

TABLE I: Taste response to different concentrations of glucose solutions and number of type 1 diabetic and non diabetic subjects.

Bottle no.	*Glucose concentration (Moles)*	*Diabetics (70)*	*Non diabetics (70)*	*P value*
1	2.0 M	6	0	
2	1.0 M	16	5	
3	0.5 M	25	16	
4	0.25 M	20	35	<0.0001
5	0.125 M	3	10	
6	0.062 M	0	4	
7	0.03 1M	0	0	

It was observed that at 0.0625 molar and lower concentration only thirty one diabetic subjects were able to recognize salt taste properly while forty eight non diabetic subjects recognize it correctly. For higher concentration that is 0.125 molar and above, thirty nine diabetic and twenty two non diabetic subjects recognized salt taste properly. In general diabetic subjects were less sensitive than non diabetic subjects (P<0.001) for salt taste.

TABLE II: Taste response to different concentrations of Nacl solutions and number of type 1 diabetic and non diabetic subjects.

Bottle no.	*Nacl concentration (Moles)*	*Diabetics (70)*	*Non diabetics (70)*	*P value*
1	1.0 M	0	0	
2	0.5 M	3	0	
3	0.25 M	12	3	
4	0.125 M	24	19	<0.001
5	0.0625 M	28	38	
6	0.0312 M	3	7	
7	0.0156 M	0	3	

Taste recognition threshold for sour taste (Table III):

It was observed that at 0.00625 molar and lower concentration only forty three diabetic subjects were able to recognize sour taste properly while sixty non diabetic subjects recognize it correctly. For higher concentration that is 0.0125 molar and above, twenty seven diabetic and only ten non diabetic subjects recognized sour taste properly. In general diabetic subjects were less sensitive than non diabetic subjects (P<0.001) for sour taste.

TABLE III: Taste response to different concentrations of citric acid solutions and number of type 1 diabetic and non diabetic subjects.

Bottle no.	*Citric acid concentration (Moles)*	*Diabetics (70)*	*Non diabetics (70)*	*P value*
1	0.05 M	1	0	
2	0.025 M	5	0	
3	0.0125 M	21	10	
4	0.00625 M	28	31	<0.001
5	0.003125 M	10	20	
6	0.00156 M	5	7	
7	0.00078 M	0	2	

Taste recognition threshold for bitter taste (Table IV):

It was observed that at 0.000062 molar and lower concentration only twenty five diabetic subjects were able to recognize bitter taste properly while forty one non diabetic subjects recognize it correctly. For higher concentration that is 0.000125 molar and above, forty five diabetic and twenty nine non diabetic subjects recognized bitter taste properly. In general diabetic subjects were less sensitive than non diabetic subjects ($P<0.001$) for bitter taste.

Sex did not seem to have a major influence on our results because sex was not strongly associated with subjects status or complications.

TABLE IV: Taste response to different concentrations of quinine sulphate solutions and number of type 1 diabetic and non diabetic subjects.

Bottle no.	*Quinine sulphate concentration (Moles)*	*Diabetics (70)*	*Non diabetics (70)*	*P value*
1	0.001 M	2	0	
2	0.0005 M	7	1	
3	0.00025 M	18	14	
4	0.000125 M	18	14	<0.001
5	0.000062 M	17	19	
6	0.000031 M	8	18	
7	0.000015 M	0	4	

DISCUSSION

Diabetic patient appear to be prone to taste disorders. However, existing literature is not unanimous about the same. The present study conducted was mainly aimed at comparing the taste thresholds of type 1 diabetics and non-diabetics (controls) and to assess whether taste impairment occurs in type 1 diabetes. The result obtained and further analysis revealed that all four taste modalities i.e. sweet, salt, sour and bitter were affected and diabetics did show deterioration in the taste sensitivity to all taste sensations (3, 6, 15, 16).

Jorgensen and Buch (1961) reported that there is no difference for the sense of taste between diabetics and normal persons (4). Dye and Koziatek (1981) reported that diabetic subjects did not differ significantly in the threshold for sucrose from non diabetic subjects (5). However, other (17, 18) reports show altered threshold only for sweet taste and not for Nacl.

The subjects with type 1 diabetes have an early impairment of sensory perception suggesting that the manifestation of diabetes might even precede clinically recognized disease (7).

The underlying cause of taste impairment in diabetes is unknown, but the probable mechanism for the heightened thresholds could be explained on the basis of different school of thoughts. Taste impairment may be a degenerative complication of diabetes mellitus; due to neuropathy of the taste

nerves (8). Diabetes have significantly accelerated level of oxidative stress (19) and these almost certainly accounts to most diabetes complication i.e. neuropathy, cardiovascular, retinal, renal etc. Ford and Hermen (1994) have shown that diabetes mellitus is a free radical mediated disease (19).

Pathological changes in the peripheral nerves in diabetes appear much earlier than the outset of clinical symptoms of neuropathy and the myelin is affected more severely than the axis cylinder. This could be due to a metabolic abnormality inherent in the diabetic state (20). Other factors such as, duration and severity of hyperglycemia are only contributing to it (2, 16).

The other school of thought specifically points out towards a significant and specific impairment in glucose taste detection. It is said that in diabetics a taste abnormality for glucose might conceivably be due to frequent elevation of the blood sugar (a “satiation effect”) (18).

Inherent or acquired defect of the taste receptor (21), or abnormality of the mechanism underlying the central appreciation of taste within the brain (21), or microangiopathy involving the taste buds (21) may also be responsible for the taste impairment.

In present study, altered sensitivity for glucose (sweet taste) was highly significant as compared to other taste modalities, there by causing blunted taste for sweet foods and it may explain the craving for sweet food that is experienced by some of diabetic subjects. This may result in increased ingestion of sweet food and beverages and worsen the hyperglycemia.

The decrease in taste sensitivity may also reflect a generalized defect in cellular glucose sensitivity involving both the glucose sensing percentage beta cells as well the specialized taste cells in the tongue (22, 23).

However in the present study, subjects were in age range from 20-45 years and the duration of diabetes was not considered for recognition of taste threshold. Therefore further study is needed to exclude the effect of duration of diabetes on taste threshold, to consider taste function as a parameter of the course of diabetes.

In spite of deterioration in quality of life that taste disorder can induce, no specific treatment is available.

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EFFECT OF EXAMINATION STRESS ON MOOD, PERFORMANCE AND CORTISOL LEVELS IN MEDICAL STUDENTS

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Abstract : Stress produces definable mental and physiological reactions in the body. Mild stress is beneficial in cognitive tasks and performance but persistently high stress may lead to neuropsychiatric illnesses like anxiety and depression. Examinations act as stressor and activate hypothalamic-pituitary adrenal axis causing an increase in cortisol level, which is reflected in saliva. Present study was done on 35 medical students. Their mood parameters were assessed, using Depression Anxiety Stress Scale (DASS) scoring, and salivary cortisol levels using quantitative ELISA. Subjects were evaluated for mood parameters two times, one during relaxed state (with no examinations in preceding 2 weeks and in coming 2 weeks) and another during stressed state (on the day of viva voce examination). The levels of mood parameters and salivary cortisol were significantly raised during examination stress. The changes in stress level significantly correlated with change in levels of anxiety and salivary cortisol though there was no significant effect on the performance. Males and females showed similar changes in mood parameters. This study suggests that as examinations act as unavoidable stressors, the medical educators as well as students should be made aware of the negative consequences of stress faced during medical training. Efficient relaxation program as well as counseling services should be provided to stressed students so that they are able to cope better with examination stress.

Key words : salivary cortisol stress anxiety depression academic performance

INTRODUCTION

Stress is defined as “a physical or psychological stimulus that can produce mental or physiological reactions that may lead to illness”. Mild stress may be beneficial

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in cognitive tasks and performance while persistently high stress may lead to anxiety and depression, which are definable neuropsychiatric disease entities. Stress response is characterized by an increase in corticosteroid release. There are considerable individual differences in this response (1). Some individuals show persistent, large cortisol increases in response to stress while others show little or no such response (2). High versus low cortisol responders may actually represent two different groups, which may differ with respect to level of perceived stress and personality traits.

Several studies have documented that medical training causes high incidences of psychological distress among students (3) and academic examination has been considered as one of the most acute stressors as performance in examinations generally has future consequences on student's career. Cortisol concentration and its rates of excretion increase in students during periods of examination stress (4). This is in response to stress which increases HPA-axis activity with a subsequent rise in salivary cortisol level (5). Salivary cortisol measurement has been considered a valuable and convenient alternative to Plasma cortisol measurement. Apart from being noninvasive, it closely reflects the concentration of free, biologically active cortisol in plasma and is independent of the rate of saliva secretion (6). It also enables demonstration of the overdrive of HP A axis, assessment of which is helpful in subjects suffering from stress, anxiety and depression. Many studies have related stress, anxiety or depression with cortisol concentration. Performance has also been reported to be affected by levels of stress (4). Present study was undertaken to explore the effect of the oral examination on perceived levels of stress, depression, anxiety and salivary cortisol response in medical students.

MATERIAL AND METHODS

Study design

This was a longitudinal follow up study in which, subjects were assessed for stress parameters and cortisol levels at two times. One in the relaxed state (with no examinations in preceding two weeks and coming two weeks); another in the stressed state(on the day of viva voce examination).

Subjects

Thirty five medical students (21 males, 14 females) who were appearing in the first professional examination were recruited for the study after written informed consent. Students with the history of neurological or psychiatric disorders, taking medicines affecting emotional status and endocrinological profile, tendency of gingival bleeding or addicted to tobacco or alcohol were excluded. The study protocol was approved by the institutional ethics committee.

Stress parameters

Subjects were given a questionnaire of 42 items for scoring Depression, Anxiety and Stress (DAS) Scale, which has 14 questions each for assessing depression, anxiety and stress levels (7).

Saliva sample collection

Subjects were instructed in advance not to eat or drink anything except water one hour before saliva collection to minimize

possible food debris and stimulation of salivation. DAS scoring and salivary sample collection was done simultaneously. Salivary samples were collected at the same time of the day (between 10:30 am and 11:00 a.m.) both during relaxed state and stressed state. Samples were stored in the deep freezer at –80°C.

Salivary cortisol assay

Salivary cortisol was measured by ELISA (DiaMetrasrl) method. The intra assay variability was 7% and Inter-assay variability was 9.3%. ELISA of all the samples was done by the same person with technical expertise who was blinded for the results of scoring and performance.

Performance

The marks obtained in the viva voce of first professional physiology examination, which was conducted by external examiners was taken as performance. Examiners were neither aware about the study nor the students enrolled in that.

Statistical analysis

Data analysis was done using SPSS version 16.0 (SPSS Inc, Chicago, IL, USA). The normality of data was tested using Shapiro wilk test. All the data were expressed as mean±SD. The pre & post data was analyzed using Paired 't' test. Group comparison was done using one way analysis of variance. Correlation analysis was performed using Pearson correlation coefficient. A two-tailed (α=2), probability value less than 0.05 ($P<0.05$) was considered significant for all statistical tests applied.

RESULTS

Of the thirty five students enrolled in the study, 21 were males and 14 females with mean age of 20.4±1.59 years, height 162.9±9.8 cm and weight 54.22±9.8 kg.

Stress, anxiety, depression and salivary cortisol levels determined during relaxed state were compared to the levels observed on the day of examination. The levels of mood parameters as well as cortisol levels both were significantly raised during examination stress (Table I).

TABLE I: Comparison of different correlates during relaxed state and exams.

Variables	*Relaxed state (n=35)*	*Stressed state (n=35)*	*'P' value*
Heart rate (beats/min)	74±12	75±6.9	0.705
Systolic BP (mmHg)	117±6.2	118±9.5	0.076
Diastolic BP (mmHg)	77±5.2	78±9.7	0.218
Stress	12.08±5.4	15.31±4.9	0.0001**
Anxiety	9.4±4.3	12.6±3.8	0.0001**
Depression	7.4±4.5	9.05±4.56	0.001**
Cortisol (ng/ml)	2.65±1.67	5.08±3.05	0.0001**

Data presented are means±SD. *P<0.05; **P<0.01.

Mood parameters and stress response in males *versus* females

Mood parameters and salivary cortisol levels were compared between males and females (Table II). Males exhibited significantly higher baseline levels of anxiety as compared to females. Baseline levels of stress and depression are also higher but not significant statistically. Both males and females showed an increase in the level of stress, anxiety and depression during exams but the difference does not reach statistical significance. Both groups showed increase in

TABLE II: Comparison of different correlates in males and females during relaxed state and exams.

Parameters	*Relaxed state*		*Stressed state*		*'P' value*
	Males (n=21)	*Females (n=14)*	*Males (n=21)*	*Females (n=14)*	
Heart rate (beats/min)	74.76±12.6	72.86±11.4	76.12±7.2	73.21±6.3	0.7398
Systolic BP (mmHg)	117.81±5.8	115.86±6.8	119.62±8.3	115.57±10.9	0.4126
Diastolic BP (mmHg)	77.90±4.4	75.71±6.1	79.33±9.19	76.00±10.4	0.4823
Stress	13.33±4.6	10.21±6.1*	16.14±4.5*	14.07±5.3	0.0131
Anxiety	10.86±3.9*	7.21±4.1*#	13.52±3.3#	11.36±4.3	0.0002
Depression	8.24±4.8	6.21±3.8	9.95±4.9	7.71±3.6	0.1186
Cortisol (ng/ml)	2.48±1.5*#	2.92±1.9	5.02±3.1*	5.19±3.1#	0.0016

Data presented are means±SD. Analysis of data was done by one-way ANOVA and post-hoc by Tukey-Kramer test. The significantly different (P<0.05) groups are flagged with * and #.

cortisol levels in response to examination stress but only the response in case of males is statistically significant. The performance was not significantly different in the two groups (Percentile marks in males and females are 76.5±12.1 and 76.27±11.2 respectively).

Correlation between changes observed in different parameters

To determine whether the changes observed in mood parameters correspond to the changes in cortisol levels and performance in examination, bivariate correlation analysis was performed. The changes in stress level were found to correlate significantly with change in level of anxiety and cortisol in subjects (Table III). Performance correlated negatively with stress and anxiety level but it was not statistically significant.

TABLE III: Correlation analysis between changes observed in different parameters of DASS scale, serum cortisol and sores in examination.

Variables		*Correlation (r)*	*Significance (P value)*
Deltastress	DeltaAnxiety	0.4	0.016*
Deltastress	DeltaDepression	0.07	0.684
DeltaAnxiety	DeltaDepression	–0.004	0.983
DeltaCortisol	Deltastress	0.387	0.022*
DeltaCortisol	DeltaAnxiety	0.384	0.023*
DeltaCortisol	DeltaDepression	–0.163	0.531
Percentile Marks	Deltastress	–0.212	0.222
Percentile Marks	DeltaAnxiety	–0.22	0.213
Percentile Marks	DeltaDepression	0.28	0.108
Percentile Marks	DeltaCortisol	–0.06	0.733

*P<0.05; **P<0.01.

Low *versus* high cortisol responders

As there are inter individual variations for cortisol response, the subjects were divided as low and high cortisol responders by taking median split of the level of change (i.e. ~3 ng/dl in our study) in cortisol due to stress (Table IV). Low cortisol responders though, had higher baseline stress, anxiety and cortisol levels, but they showed significantly low response/change for perceived stress, anxiety and cortisol levels during examination stress as compared to high responders. There was no significant difference, observed in the performance of the two groups.

TABLE IV: Comparison of mood parameters and performance in high cortisol responders and low cortisol responders. Significance (P value) determined using students t test.

Variables	*Delta cortisol < 3 ng/mL (n=18)*	*Delta cortisol < 3 ng/mL (n=17)*	*'P' value*
Stress	12.2±6.25	11.9±4.6	0.880
Deltastress	2.1±2.9	4.5±3.4	0.029
Anxiety	9.94±4.9	8.82±3.7	0.455
DeltaAnxiety	2.22±2.5	4.34±3.0	0.031
Depression	7.33±4.7	7.5±4.5	0.901
DeltaDepression	2.1±3.3	1.17±1.6	0.327
Cortisol (relaxed)	3.13±1.6	2.14±1.6	0.081
Percentile Marks	76.7±11.6	76±11.9	0.878

Data presented are means±SD.

DISSCUSION

In this study, we evaluated changes in the level of stress, anxiety, depression and salivary cortisol among medical students due to viva voce examination and correlated it with their academic performance. Results show that viva voce examination leads to significant changes in the level of mood parameters and salivary cortisol. Changes in level of cortisol showed a significant correlation with that of stress and anxiety. Performance was negatively correlated with changes in level of stress and anxiety, but it was not statistically significant. Various studies both on animals and human studies have indicated that stress and glucocorticoids may impair memory and cognitive function (8, 9).

Studies have shown that written examinations may (10) or may not (4) cause increase in cortisol levels; however, oral examinations routinely elicit a cortisol response and feelings of stress (11), and have been shown to cause greater cortisol release and feelings of anxiety than written examinations (4). Shah et al. (2010) have also reported a negative correlation between perceived stress and academic performance, which was not significant (12). Authors suggested that only acute stressors may be responsible for affecting academic performance. Also the students who are striving hard to perform well in the exam may be stressed. Their Individual coping styles and skills along with their access to different forms of social support may play a role in negating the effect of stress on academic performance. Sansgiry et al. (2006) also found an insignificant negative correlation between academic performance and test anxiety (13). Authors suggested efficient counseling service in their institution as one of the causes for not getting a significant association between performance and test anxiety. According to them such programs are efficient in improving academic performance, which has also been supported by others (14).

Medical curriculum is stressful (3) and varied levels of stress have been reported amongst medical students and health care professionals (11). Vaidya and Mulgaonkar (2007) also found increased level of stress and anxiety among first year medical students and they found academic pressure to be most responsible for this (15). They could not get any correlation between stress, anxiety, depression and academic performance. Authors suggested that the students who perceive tests/exams as a burden experience it as stressful situations while for others, who consider exams useful, it may assist them in their learning. Previous studies have also reported that academics/exams are common sources of

stress among medical students (16, 17) and anxiety and stress due to examination has a negative effect on the performance (18). Baseline stress, anxiety, and depression were higher in males similar to the findings of other studies (19) and viva voce examination led to a significant rise of cortisol level in them which is in accordance with the findings of others (20). However, females showed a trend of increased salivary cortisol with stress though it was not significant. Females vary in their response to stress corresponding to the phase of their menstrual cycle. They have blunted responses in the follicular phase and increased responses similar to those of men in the late luteal phase (20). In our study we did not evaluate females according to their phase of menstrual cycle, which may be one of the causes for statistically insignificant rise in cortisol in females. Moreover, variations in cortisol response probably reflect differences in the ways male and female perceive or cope with specific psychosocial situations. Stressors such as public speaking and mental arithmetic provoke greater cortisol changes in males than in females (21).

In the present study basal salivary cortisol levels were not found to be related to basal levels of DASS scores. Bradtstadter et al., (1991) and Ockenfels et al, (1995) also reported no association in levels of cortisol and mood parameters in healthy subjects (22, 23). In studies by Schaeffer et al., (1984) and Linkowski et al. cortisol levels have been reported to be related to mood parameters but these studies were done in chronically distressed subjects or psychiatric patients (24, 25). A subgroup comparison of the students as low and high cortisol responders was done by taking a median split for the relative change in cortisol level during viva compared to baseline. We found that high cortisol responders were significantly more stressed (P=0.029) and anxious (P=0.031) during viva, though they had lower baseline values as compared to low responders. Thus students who perceived greater stress and anxiety during examination showed a significant rise in cortisol levels as reported in other studies (11, 26), though there was no difference in the performance of the two groups. Cortisol levels were raised on the day of viva voce which reflects the up regulated HPA axis in response to stress. Examination stress leads to mood changes, which effect cortisol level, both of which in turn may affect the academic performance of the subjects. Loft et al., (2007) in contrast reported a decrease in cortisol levels (27).

In the present study association was sought between anxiety, depression, stress, salivary cortisol and performance during professional viva voce examination. The results reveal that examinations act as an unavoidable natural stressor and lead to increased stress, anxiety and depression in students, consequently excite HPA axis, resulting in increased release of cortisol. Despite changes in mood and cortisol levels, performance was not affected significantly in this group of students. To an extent cortisol may be helpful in dealing with the increased demands of the body during stress, but an excessive and persistent increase may lead to various ailments. Due to certain limitations, we were not able to assess post examination changes in mood and cortisol level, which would have led us to the conclusion that whether these changes were

persistent or only for a short duration. This was the limitation of our study, which may be evaluated further on a larger sample size along with the various other factors, which may affect performance apart from mood changes and cortisol levels.

The medical educators as well as students should be made aware of the negative consequences of stress faced during medical training and an efficient relaxation program as well as counseling services should be provided to such stressed students to enhance their academic performance. Education system needs to develop better evaluation techniques which cause less distress among students and educators, need to develop and promote better support programs for struggling students for their well being.

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AN INNOVATIVE DEVICE FOR CREATING TISSUE PLANE CLEAVAGE BY HYDRO-DISSECTION BASED ON LEVER AND ERGONOMIC PRINCIPLE

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Abstract : In the Third world countries, the occupational health of a Reconstructive Surgeon attracts due attention from the applied physiology fraternity, where the massive amount of surgical workload causes chronic fatigue and repeated stress and injury. The knowledge of human physiology and the science of ergonomics analyze these challenges and formulate guidelines for creating a work environment that is safe and comfortable for its operators. Presented here is an innovative, cost effective, sterilizable, manually controlled hydrodissection instrument for surgery. This easy to make Syringe Pressure Gun (SPG), has revolutionized the face of cleft palate surgery reducing the surgical time to 50% and the palatal fistula rate from 3% to Zero percent. The effects were studied on patients and the operating surgeon both. The experimental group comprising of 1500 cleft palate patients in whom the gun was used during surgery as compared to 500 controls showed statistically highly significant results in terms of reduction in average bleeding in millilitres ($P<0.05$), average operating time in minutes ($P<0.001$), palatal fistula formation ($P<0.005$) and reduction in surgical complications like flap necrosis. The results in the operating surgeon (self control) on using the instrument, showed highly statistically significant fall in the muscle strain induced by tedious surgical manoeuvres, as studied by EMG ($P<0.005$), subjective hand grip pain and tiredness on a scale of 0-10, high convenience in flap dissection and therefore work performance improved in spite of the high volume of surgery. This ergonomic innovation will provide clues for future inventions based on physiological principles for improving the occupational health of the doctors and outcome of the patients.

Key words : cleft palate syringe pressure gun hydro dissection

INTRODUCTION

Occupational health and ergonomics is an integral part of applied physiology. Muscular fatigue of a surgeon, due to non availability of ergonomically designed surgical instruments can adversely affect the patient outcome (1). Advancements in the basic sciences

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contribute to the fundamental knowledge base and supports future invention. Extensive work still lacks on the innovations by physiologists aimed at patient and the clinician's advantage (3). The designed device presented here is entirely based on the need of the times which included occupational health of the surgeon, better results in the patient and the applied physiology broadening its horizon. The idea of the present innovation was conceived to find a solution to reduce fatigue experienced during cleft palate repairs by one of the authors, as his surgical workload was very high and the fatigue was affecting his output. A accurately controlled massive manual effort was required to push the plunger of the 10 ml injection syringe against great resistance offered by the deranged palatal mucoperiosteum densely adherent to palatine bone, while making submucoperiosteal injections to create a tissue cleavage during cleft palate repairs. This in turn affected the surgical outcome where very fine and precise movements are required for a better surgical outcome.

Surgical Physiology : In palatal surgery, mucoperiosteal flaps need to be carefully separated off dense fibrous union with the thin palatine bone, and be islanded carefully on the vascular pedicle based on the greater palatine artery. It requires tough dissection with very tender instrument manoeuvring through the small oral commissure of usually very young patients. During this dissection the tissue planes are often mutilated leading to bleeding and thus further compromising the visibility during surgery. The result is, a high incidence of dehiscence of the repair and a palatal fistula, making the patient a cripple for life. To tackle with these problems, surgeons inject submucoperiosteally an injection of vasopressin solution for vasoconstriction. It also serves the purpose of hydrodissection that creates a very safe plane of cleavage between the tissues, thus separating the mucoperiosteum from the bone even before the knife is used. Along with this it provides a rapid expansion of the usually sparse palatal soft tissues, thus facilitating an easy, tension less repair.

Such an injection requires generation of very high pressures through a simple 10 ml hypodermic syringe-often to the tune of 1300 PSI (pounds per square inch) as seen in dental injections where a low volume of the local anaesthetic (1-2 ml) is given over a period of 5-10 minutes (4). In palatal hydrodissection submucoperiosteal delivery of large volumes (up to 50 ml) at such a slow rate will waste precious operating time and thus rapid injection at a much higher pressure is required. Manual generation of such high pressures over repeated surgeries causes fatigue and pain in the surgeon's hand, even before the surgery starts, thus reducing accuracy of the skill.

Expensive computerized expensive devices for injection of the small volumes of local anaesthetic (1-2 ml) are commercially available, but with no control of pressure, and a very slow delivery of the drug at the rate of 1ml per minute. Surgery often is an art of feeling the tissues, their resistance and 'give-way' feel acts as a guide to surgical manoeuvres. Average pressure developed during injection of local anaesthetic manually or through a motorized device in such a case reaches up to just 300 mm Hg (5); hence the hydrodissection is often

incomplete especially if the procedure is to be repeated several times in a day. None of the marketed instruments fulfill these demands, therefore, a Syringe Pressure Gun (SPG) was indigenously designed in the Physiology Lab using the principles of lever and ergodynamics to reduce surgeon's discomfort, to improve the efficiency and convenience of surgery on one hand; while on the other hand to reduce the rate of complications as well as the time taken to dissect the tissues in an arduous field.

MATERIAL AND METHODS

Material

1. After carefully observing videos of the hydrodissection procedure at palate surgery and keeping in mind the limited access into the mouth of patient under general anaesthesia, a sketch of the device required was designed in collaboration with the surgeon. The innovative, cost effective, ergodynamic, sterilizable, manually controlled hydrodissection device (SPG) was created by modifying a simple injection gun used by civil construction workers to squeeze and paste silicone sealant used for sealing window panes. Such a gun is easily available at hardware general stores for merely a 100 rupee note.

2. The gun works on the basis of first class lever in which the trigger lever acts as the effort arm and the advancing rod as the load arm.

3. The design of silicone-bottle holding arms of the gun was modified to suit the needs of the procedure. A semi cylindrical steel pipe large enough to accommodate a 10 ml syringe was brazed to the arms to create the SPG.

4. The device was designed considering cost effectiveness, ergonomics and all the drawbacks of the previous devices.

Method

Study Groups

A. 2000 Cleft Palate patients undergoing palatal repair surgery were undertaken and randomly divided as –

   1. Device group. (N=1500) in whom the device was used for hydrodissection.

   2. Controls. (N=500) in whom the vasopressin was injected manually through 10 ml syringe.

B. The operating surgeon himself (self control): Surgery done with and without the use of gun.

Procedure

Use of the SPG

1. A duly informed consent was obtained from the patient or guardian. Under general anaesthesia the innovative SPG was used to inject into the sub-mucoperiosteal plane, diluted vasopressin solution through a 24 gauge hypodermic needle fitted to a 10 ml syringe, to hydrodissect and elevate the mucoperiosteal flaps off their bony attachments.

2. With every full range stroke of the effort arm lever (40 degrees rotation and 48 mm movement at farthest point of the arc), the load arm rod moved the syringe plunger to deliver 1 ml of drug against

as high pressure as required till hydrodissection was achieved as perceived by the operator as a give-way feel, complemented by a visible bleb like elevation of the palatal flaps thus rapidly expanded. The surgical procedure for palatal reconstruction was then carried out as usual, using routine techniques of repair. In both the group of patients, the parameters studied were –

1. Average bleeding in millilitres = [weight of wet gauze (blood plus fluid used in hydrodissection)] - [weight of the dry gauze plus weight of the injected fluid].
2. Average operating time in minutes: From start of injection till the last suture, assessed by stop watch.
3. Palatal fistula, wound dehiscence and flap necrosis (percentage of cases).

In the single operating surgeon, the parameters studied were :

1. Electromyography (EMG): Electromyogram activity as an indicator of muscle tension was recorded on the thenar group of muscle. After degreasing the skin surface, the EMG (mV) was recorded using large surface electrodes of an automated biofeedback apparatus (J & J Engineering, USA) where in the electrodes were placed on the palmar skin overlying thenar eminence. The EMG was recorded immediately before starting hydrodissection and after the surgery was over.
2. Convenience in flap dissection: on a subjective scale of 0-10; (0: least convenient; 10: most convenient dissection).
3. Subjective hand grip pain and tiredness: on a scale of 0-10 (0: least; 10: maximum).

The observations were compiled and the results tabulated and compared with the help of the computer software – 'Microsoft Excel' (Microsoft Office XP). Analysis of the data was also done through the 'Data Analysis Pack' of the same software.

RESULTS

The study was conducted on 2000 patients of primary (n=1523) and secondary (n=477) cleft palate repairs which were randomly divided into SPG group (n=1500) and controls (n=500). The average age of the patients was 9.37±8.14 years, with 1265 males and 735 females. There was a statistically significant reduction in the bleeding, operating time, wound dehiscence ($P<0.05$) and occurrence of palatal fistula. The EMG of the surgeon's hand muscles after usage of the gun showed marginal increase of muscle tension as compared to the statistically significant higher values in the controls ($P<0.005$). With the use of SPG it was more convenient to

TABLE I: Effect of the use of innovative SPG in palate surgery.

	Control group	*Device group*
Average Bleed	142	35
Average Operating Time	87	42
Palatal Fistula (%)	3	0
Preoperative EMG of Surgeon's Hand (mV)	5.79	5.82
Postoperative EMG of Surgeon's Hand (mV)	9.84	6.92
Convenience of surgery on scale of 0-10	9	4
Pain & tiredness on scale of 0-10	8	2

dissect the flap, and there was less postoperative pain and fatigue in the operator's hand. The results are summarized in Table I.

DISCUSSION

Occupational and environmental health, with a focus on human integrative, clinically oriented and translational physiology, is now understood as 'applied physiology' by the medical world including the western indexed journals (6). The present innovative study intends to focus attention of the physiologists and the clinicians towards an area of applied sciences which works together to improve the health of both the doctor and the patient. It was noticed that in cleft palate hydrodissection, the primary problem of the surgeon was poor ergonomics i.e. a mismatch of the required and available effort in making the forceful injection of the drug to facilitate hydrodissection. It was noted that the surgeon's hand using the ordinary 10 ml injection syringe is not able to generate the required pressure of up to 1300 PSI in repeated surgeries, and on a repeated attempt to do so, he experienced fatigue of hands, and stress of pain, thus reducing the accuracy of surgical manoeuvres.

Ergonomics is the science of designing the job, equipment, and workplace to fit the worker. The International Ergonomics association defines ergonomics (or human factors) as the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance. Optimal ergonomic design is necessary to prevent repetitive strain injuries, which can develop over time and can lead to long-term disability (7).

To rectify this mismatch, the lever principle was sought for. Lever *(from French lever, "to raise", c.f. a Levant)* is a rigid object that is used with an appropriate fulcrum or pivot point to multiply the mechanical force that can be applied to another object. This leverage is also termed mechanical advantage, and is one example of the principle of moments.

To facilitate a high pressure injection using less mechanical effort, a device based on the first class lever principle was needed. A first-class lever has the fulcrum located between the input effort and the output load. In operation, a force is applied (by pulling or pushing) to a section of the bar, which causes the lever to swing about the fulcrum, overcoming the resistance force on the opposite side. The fulcrum may be at the centre point of the lever as in a seesaw or at any point between the input and output, and the output depends on the difference in the length of the load arm and the effort arm (8).

This innovative device was crafted by modifying a simple inexpensive (Rs. 100 only) silicone injector gun with the help of a brazing technician, to help fit an ordinary 10 ml syringe to the load arm, which injected 1ml fluid by advancement of the load arm on every full range stroke of the effort arm, which moved by an angle of 40 degrees and a distance of 48 mm at the farthest point of the arc thus translating an 8 mm piston movement for every ml of fluid expulsion,

and augmenting the injection pressure to 6 times. The resistance at the lever with practice gives an accurate idea of the tissue resistance and give-way feel to the user. One SPG has proved to work well for over 2000 cases in our study, making it very cost effective. Such a utilization of the physiological knowledge of ergodynamics of hand and of the principles of leverage has facilitated development of a device which has revolutionized the face of a very tedious surgery.

The device based on the first class lever principle proved to be useful in various ways.

1. It reduced the effort and time required in local infiltration and hydrodissection.

2. It effortlessly expanded the palatal tissues to facilitate a tensionless closure and hence reducing the wound dehiscence.

3. It reduced bleeding by separating the tissue planes with less amount of sharp dissection as also seen in previous studies (9).

4. As compared to expensive motorized and computerized devices meant for small volume local anaesthetic injections as in dental surgery, this innovative mechanical device is capable of delivering large volumes of the drug with an excellent “feel” of tissue resistance and of give way, while enabling the surgeon to clearly visualize the elevation of the palatal mucosa even before using the knife (4, 10).

5. It is inexpensive, and can be very easily designed, and has revolutionized the face of cleft palate surgery reducing the surgical time to 50%, and a fistula rate from 3% to Zero percent.

6. It showed less muscle strain and minimized fatigue of the surgeon's hand as seen by limited alterations of surface EMG (11).

Our results clearly indicate that improvement in surgical outcome in a comfortable and ergonomic workspace can contribute to an enhanced situational control and a decreased level of physical workload. The results corroborate with the findings of previous workers who have also seen improved performance and reduced cognitive stress levels as well as physical discomfort to the surgeon in robotic surgery (12).

The indigenous device which was developed from the physiological knowledge of ergodynamics and leverage has proved to be a very useful, cost effective, sterilizable, manually controlled hydrodissection tool which has considerably improved the, convenience and results of surgery. This is truly applied physiology, used extensively now for the assistance of the surgeon and the patients undergoing surgery. Similar ergonomic devices are needed in many disciplines of life to reduce effort, increase output and the quality of output.

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EFFECT OF YOGA PRACTICES ON PULMONARY FUNCTION TESTS INCLUDING TRANSFER FACTOR OF LUNG FOR CARBON MONOXIDE (TLCO) IN ASTHMA PATIENTS

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Abstract : Prana is the energy, when the self-energizing force embraces the body with extension and expansion and control, it is pranayama. It may affect the milieu at the bronchioles and the alveoli particularly at the alveolo-capillary membrane to facilitate diffusion and transport of gases. It may also increase oxygenation at tissue level. Aim of our study is to compare pulmonary functions and diffusion capacity in patients of bronchial asthma before and after yogic intervention of 2 months. Sixty stable asthmatic-patients were randomized into two groups i.e group 1 (Yoga training group) and group 2 (control group). Each group included thirty patients. Lung functions were recorded on all patients at baseline, and then after two months. Group 1 subjects showed a statistically significant improvement ($P<0.001$) in Transfer factor of the lung for carbon monoxide (TLCO), forced vital capacity (FVC), forced expiratory volume in 1st sec (FEV_1), peak expiratory flow rate (PEFR), maximum voluntary ventilation (MVV) and slow vital capacity (SVC) after yoga practice. Quality of life also increased significantly. It was concluded that pranayama & yoga breathing and stretching postures are used to increase respiratory stamina, relax the chest muscles, expand the lungs, raise energy levels, and calm the body.

Key words : asthma yoga

INTRODUCTION

Bronchial asthma besides being a chronic inflammatory disease of the airways also has psychosomatic imbalance and an increased vagal tone as its etiopathogenesis (1, 2).

Yoga is an ancient discipline, which by increased mental and physical control of the body, aims to affect union of the soul with a universal spirit. Yoga is taught in many steps of which one, pranayama, deals explicitly with control of breathing and its synergy. Pranayama is widely believed to be helpful in the management of asthma, and beneficial effects of yogic methods, which

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include pranayama, have been reported in uncontrolled and open studies (3-8). Nagarathna and Nagendra have shown significant improvement in numbers of asthma attacks in asthma patients undergoing yoga training as compared to the control (4). Studies have been conducted to understand the changes occurring during various yogic exercises. A study on the efficacy of yoga on the management of bronchial asthma demonstrated that yoga results in measurable improvement in subjective as well as objective outcomes in bronchial asthma (9). Studies done by several researchers showed that regular practice of yoga lead to significant improvement in pulmonary function which include increase in peak expiratory flow rate (PEFR), vital capacity (VC), forced vital capacity (FVC), forced expiratory volume in 1st sec (FEV_1), maximum mid expiratory flow rate (MMFR). It decreases weekly number of attacks of asthma, symptom scores and scores for the drug treatment (10, 11, 12). In the present study diffusion capacity as well as the quality of life was also assessed. This yogic regimen may change the milieu at the bronchioles and the alveoli particularly at the alveolo-capillary membrane to facilitate diffusion and transport. Main objective was to see the effect of yogic techniques on diffusion capacity in asthma patients, so it is included in this proposed study.

MATERIAL AND METHODS

The study was conducted on 60 diagnosed stable patients of bronchial asthma of either sex having disease duration of more than one year. The patients were recruited from the medicine outpatient department (OPD) of GTB hospital, Delhi. The diagnosis was based on paroxysms of dyspnoea, wheezing and cough, which improved either spontaneously or with drug therapy. Non smokers, in the age group of 18-60 years with mild to moderate grades of bronchial asthma as per GINA (Global Initiative for asthma) guidelines (Mild- FEV_1>80% predicted, Moderate-FEV_1 = 60-80% predicted) were included. Subjects with a history of an exacerbation or respiratory tract infections, current smokers, pregnant or lactating women or any other disorder were excluded. The medication for asthma was kept same throughout the study period. The study was explained to the patients and their signed informed consent was taken. Ethical clearance was also obtained from UCMS ethical committee.

Patients were randomized into the following two groups: Group 1 (Yoga training group) and Group 2 (control group). Yoga includes Pranayama (30-35 min), asanas (10 min), meditation (10 min) and life style modification.

1. Pranayama: Bhastrika (slow and deep inhalation and exhalation for 2 min), Anulom-Vilom (alternate nostril breathing while sitting in sukhasana for 15 min), Kapalbhati (forceful expulsion of the breath by contracting the abdomen for 10 min), Bahaya pranayama (deep, slow and complete breath and hold the breath for 10 sec for 4 times), Bhramri (deep and slow breath and slowly exhale while producing sound like bee for 5 times), Udgit Om uchcharan (inhale slowly, deeply and chanting Om while exhaling for 5 times) (13).
2. Suryanamaskar (Sun Salutation Pose).

3. Asanas:

Tadasana (Palmtree pose)

Paschimotansana (Front Leaning Pose)

Mandukasana (Frog pose)

Patients came to yoga centre in the department of physiology, University College of Medical Sciences, Delhi for 5-6 days initially, for getting proper yoga training by a yoga expert. Thereafter they were practicing yoga for an average of 40-50 min daily at home for 2 months. In between this period they were called to the yoga centre regularly after every 7 days to see as to whether they were doing the yogic exercises properly. Lifestyle modification was assessed by giving them proper diet chart to follow, in which they were instructed to take more fruits and vegetables, avoid drinking alcohol and smoking, proper sleeping of 7-8 hours.

Subjects were asked to keep their daily records of breathing exercises, medication use and asthma symptom severity during day and night, plus activity limitations due to asthma. All the patients received same yoga training.

Parameters : The pulmonary function tests were assessed prior to yoga training and at the end of 2 months of yoga. The pulmonary function tests were carried out on each stable subject using computerised medisoft instrument (HYP'AIR compact). The patients were acclimatized to the laboratory for 10 min. The level of the mouth piece was adjusted so that the patient was comfortable. Adequate demonstration was given till subject has comprehended the instructions. Pulmonary function tests were carried out in the morning between 9:30 am to 11 am.

Patients were than subjected to pulmonary function tests including Transfer factor of the lung for carbon monoxide-TLCO (ml/mm Hg/min)., Forced Vital Capacity - FVC (1), Forced Expiratory Volume in first second – FEV_1 (1), Ratio of FEV_1/FVC (%) expressed in percentage, Peak Expiratory Flow Rate – PEFR (l/sec), Maximum Voluntary Ventilation – MVV (l/min), Slow vital capacity – SVC (1). A total of 3 tests were carried out and the best of the three fulfilling the criteria of reproducibility and vitality were considered for analysis.

Quality of life was measured by using a self-administered Asthma Quality of Life Questionnaire (AQLQ) which is available in bilingual form, i.e. English and Hindi (14).

The AQLQ is a 32-item disease specific questionnaire that has been validated to measure the problems that adult patients with asthma experience in their daily lives Questionnaire has 32 items in four domains: activity limitation (11 items), symptoms (12 items), emotional function (5 items), and environmental stimuli (4 items). The response options for each of the 32 items are on 7 point scale, where 1 indicates maximal impairment and 7 indicates no impairment. At each visit, patients were asked to recall what impairment they would have experienced during the previous 2 week and to respond using 7-point response option. The response was recorded. For each of the 32 items in the Asthma Quality of Life Questionnaire, patients were asked to recall what impairment they had experienced during the previous 2 week and to respond using 7-point response options. The score for each sub-domain was also calculated as the

mean score for items pertaining to that sub-domain.

Data was analyzed by one-way ANOVA and Tukey Krammer post-hoc test.

RESULTS

Four subjects withdrew from the study; one found the lung exercises to be inconvenient, and three had respiratory tract infection. Hence complete data are presented for 60 subjects. Pulmonary parameters were improved from baseline values.

The mean±SD of TLCO FVC, FEV_1, FEV_1/FVC, MVV, SVC, PEFR and FEF25-75% in group 1 before and after yoga practices are given in table 1. While in group 2 i.e control group do not showed much changes when compared with group 1. After yoga the patients showed significant improvement in TLCO from 21.25±4.75 ml/mmHg/min to 23.35±4.47 ml/mm Hg/min FVC from 3.23±0.93 1 to 3.43±0.93 1, FEV1 from 2.80±0.71 1 to 2.80±0.71 1, FEVI/FVC from 81.35±7.08% to 82.19±5.24%, PEFR from 5.53±1.46 l/sec to 6.41±1.03 l/sec MVV from 74.31±20.11 l/min to 85.33±24.42 l/min, SVC from 2.84±0.80 1 to 3.20±0.83 1, thus showing significant improvement in

TABLE I: Showing pulmonary function tests of asthma patients at baseline and after 2 months.

Parameter	*Control group*		*Yoga group*		*P value*
	Pre (n=15)	*Post (n=15)*	*Pre (n=15)*	*Post (n=15)*	
BMI	22.81±3.15	22.63±3.09	22.94±4.38*	22.23±436#	f<0.05
TLCO	21.71±5.77	21.30±6.88	21.25±4.75*	23.35±4.47#	f<0.001
FVC	3.55±0.79	3.60±0.81	3.23±0.93*	3.43±0.93#	f<0.001
FEV_1	2.76±0.59	2.80±0.58	2.62±0.67*	2.80±0.71#	f<0.001
FEV_1/FVC	77.32±3.31	79.41±3.56	81.35±7.08*	82.19±5.24#	f 0.05
MVV	75.86±20.11	74.84±26.11	74.31±20.11*	85.33±24.42#	f<0.001
SVC	3.24±0.88	3.29±0.77	2.84±0.80*	3.20±0.83#	f<0.001
PEFR	6.00±1.74	6.26±1.48	5.53±1.46*	6.41±1.03#	f<0.001
	3.65±1.24	5.34±6.67	3.11±0.92*	3.38±0.86#	f>0.10

Data presented are mean±SD. Analysis of data was done by one-way ANOVA and post-hoc by Tukey-Krammer test. The * depicts pre yoga group comparison with control pre and the # depicts post yoga group comparison with control post and the f depicts pre yoga comparison with post yoga. *P>0.001, #P>0.001, f P<0.001.

TABLE II: Showing Quality of life in asthma patients at baseline and after 2 months.

Quality of life	*Control group*		*Yoga group*		*P value*
	Pre (n=15)	*Post (n=15)*	*Pre (n=15)*	*Post (n=15)*	
Symptom domain	4.31±0.94	4.75±1.07	4.56±0.43*	6.21±0.63#	f<0.001
Activity domain	4.18±0.77	4.57±0.64	4.38±0.91*	6.01±0.73#	f<0.001
Emotion domain	3.32±0.59	3.80±0.95	4.16±0.73*	5.58±0.82#	f<0.001
Environment domain	3.18±0.65	3.46±0.87	3.80±1.13*	4.80±1.07#	f<0.001

Data presented are mean±SD. Analysis of data was done by one-way ANOVA and post-hoc by Tukey-Krammer test. The * depicts pre yoga group comparison with control pre and the # depicts post yoga group comparison with control post and the f depicts pre yoga comparison with post yoga. *P>0.001; #P<0.001; f P<0.001.

Pulmonary parameters as compared to baseline, P<0.001. The mean±SD of Quality of life- Symptom domain from 4.56±0.43 to 6.21±0.63, activity domain from 4.38±0.91 to 6.03±0.73, emotion domain from 4.16±0.73 to 5.58±0.82, environment domain from 3.80±1.13 to 4.80±1.07 thus, showing significant improvement in quality of life.

DISCUSSION

Yoga has been used to treat respiratory problems in Hindu cultures for centuries, but has received little attention from physicians. Several studies have claimed yoga techniques to be helpful in the treatment of asthma (3-9), but virtually we have'nt come across any study in India showing the effect of yoga on diffusion capacity in asthma patients. The mechanism by which yoga may affect diffusion capacity can be- pranayama; a well regulated breathing exercise increasing the depth of breathing as compared to normal breathing. By doing so, it expands the lungs more than during normal breathing and thus recruiting previously closed alveoli which results in increased surface area of respiratory membrane and air diffusion across the membrane. Due to improved breathing pattern respiratory bronchioles may be widened and perfusion of a large number of alveoli can be carried out effectively (15). The mechanisms by which changes in respiratory functions occur are: Yoga exercises improve respiratory breathing capacity by increasing chest wall expansion and forced expiratory lung volumes (16). Yoga improves lung capacity, a significant increase in the oxygen consumption 15 to 25% (17, 18). It is also known that yoga appears to result in somatic muscular relaxation finally resulting in reduction in airway resistance; it also increases the compliance of lung. Yoga asanas, which are the controlled stretching postures, aid pranayama by enhancing the strength of respiratory muscles, diaphragm and upper abdominal muscles. Previously, it was reported that yoga training for 6 months improved lung function, respiratory muscle strength & endurance in healthy subjects (19). However different yoga training produced different results on the cardiopulmonary function in young healthy Indians (20). Our results are comparable with Nagarthana & Nagendra which showed significant increase in peak flow rate & decrease in number of asthma attack. They have suggested that yoga techniques reduce psychological over activity and emotional instability, and thereby reduce efferent vagal discharge (5). Significant increase in FEV_1, FEV_1/FVC, PEFR & $FEF_{25-75\%}$ was also observed by various authors after yoga intervention (10, 11, 21). Our findings indicate that yoga exercises may lead to overall improvement, as at entry point of the study, patients taking average 2 puff of $ß_2$ agonist a day, was reduced after 2 months of yoga. S Cooper et al suggests that Buteyko breathing technique can improve symptoms and reduce bronchodilator use in patients of asthma, but lung functions does not change significantly (22).

Pranayama may have psychophysiological benefits by increasing the patient's sense of control over stress and thus aids in reducing their autonomic arousal factors. Yoga stabilizes autonomic equilibrium with a tendency towards parasympathetic dominance rather than stress-induced sympathetic dominance. Yoga therapy readjusts the autonomic imbalance, controls the rate of breathing and relaxes the voluntary inspiratory and expiratory muscles, which results in decreased sympathetic reactivity (23, 24).

In conclusion, the reduction in psychological hyper-reactivity and emotional instability achieved by yoga can reduce efferent vagal reactivity, which has been recognised as the mediator of the psychosomatic factor in asthma.

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ASSESSMENT OF KNOWLEDGE, ATTITUDE AND PRACTICES OF TRAFFIC POLICEMEN REGARDING THE AUDITORY EFFECTS OF NOISE

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Abstract : The objectives of the present study were to (i) estimate noise levels at major traffic junctions in Bengaluru City, and (ii) assess the knowledge, attitude and practices of traffic policemen deputed at those junctions towards the auditory effects caused by noise pollution. The present questionnaire based study was carried among 60 traffic policemen. Road traffic noise was measured at different places in Bengaluru city using Sound level meter and it ranged from 71.2 to 91 dB. The questionnaire included the questions regarding the self assessment of the policemen about their hearing ability, past and present exposure to loud sound and the use of personal protective devices such as ear plugs and ear muffs. The questionnaire was filled by the subjects and the data was analyzed. The mean age was 42.2±7.4 years and the mean year of exposure was 10.82±8.53 yrs. Only 3.33% of the subjects felt that their hearing ability was below average. Thirteen subjects reported that they usually missed some conversation over phone while 25% reported similar condition while talking to someone in crowd. 16.66% had work related tinnitus (> once a day) and experienced it more during working hours. None of them used ear plugs/ ear muffs and the reason for non-usage was nonavailability (100%). The self assessment of hearing by traffic policemen suggests that most of the traffic policemen have normal hearing. However, a systematic study with Audiometry of these subjects is recommended.

Key words : bengaluru noise levels traffic policemen

INTRODUCTION

Noise has been a bane and seems to have altered the ecological balance. Noise pollution in mega cities is considered to be one of the most important and pressing problems. A major contribution to the noise is vehicular noise (1). The IT capital of India, Bengaluru in 21st century has seen an unprecedented increase in the vehicular noise caused by exponential increase in the number of vehicles. The traffic policemen

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engaged in controlling traffic noise, particularly at heavy traffic junctions, belong to the high risk group to be affected by health hazards of noise and air pollution. Most of the traffic policemen use a mask to prevent the ill effects of air pollution. However, a majority of them remain unaware about the health effects of noise on their hearing ability as this is an insidious process and takes long time to become overt (2, 3, 4, 5, 6). Noise louder than 80 dB (decibels) is considered to be potentially hazardous and continued exposure to >85 dB of noise may cause gradual but permanent damage to hearing. Health effects of noise include both the auditory as well as non auditory effects. Many studies have been carried out to study these effects in different categories of population exposed to high intensity and frequencies of sound in their workplaces (7, 8, 9, 10). There are only minimal studies carried out regarding the estimation of noise levels and auditory effects of noise generated by automobiles among traffic policemen particularly in India. This may be one of the reasons for not providing hearing protection devices to this group of work force. However, the need should be felt by the traffic policemen themselves and this can happen only when they have adequate knowledge about the associated health hazards. With this background, the present study has been carried out to estimate noise levels at major traffic junctions in Bengaluru and to assess the knowledge, attitude and practices of traffic policemen deputed at those junctions towards the auditory effects caused by noise pollution so that some preventive modalities for hearing conservation in the form of safety equipments and duty scheduling for exposure limitation can be suggested.

METHODS

Noise level measurements were taken using Sound level meter at various points in Bengaluru. The Sound level meter is the instrument that displays the amplitude level of sound as its being recorded. In this study, sound level meter of 2231 type with the Front Plate BZ 7110 and software Module “M-11” was used.

The amount of Peak, SPL (sound pressure level), SEL (sound exposure level), Leq (Equivalent continuous sound pressure level) and Max Peak were measured. All the measurements were done in the peak of the traffic. A survey of exposure times, experience of adverse effects, attitudes towards noise levels and hearing protection, use of hearing protection devices and knowledge of noise induced hearing loss were undertaken. Present questionnaire based study was carried out among 60 traffic policemen deputed at the junctions where noise levels were measured. Informed consent was taken. Ethical clearance was obtained. The questionnaire (2) was filled by the subjects and it included the questions regarding the self assessment of the policemen about their hearing ability, past and present exposure to loud sound and the use of personal protective devices such as earplugs and earmuffs. The results thus obtained were tabulated and analyzed.

RESULTS

Table I shows the average of road traffic

TABLE I

Sound pressure level (dB)	*Sound exposure level (dB)*	*Peak (dB)*	*Leq (dB)*	*Maximum peak (dB)*
80.86±6.33	106.1±3.26	92.87±5.85	82.31±3.76	111.91±5.39

Data presented are mean±SD.

noise levels (Sound pressure, sound exposure, peak, Leq & maximum peak) measured at various busy traffic junctions in Bengaluru.

Table II shows the distribution of study subjects The mean age was found to be 41.76+9.70 years. The mean duration of exposure to noise was 10.82+8.53 years. Almost all the subjects had 5-8 yrs of schooling, with majority of the subjects having middle and secondary level of educational qualification.

TABLE II: Distribution of study subjects.

Characteristics	*Number*	*Percentage*
Age (in years)		
<35	14	23.3
35-45	17	28.3
>45	30	50
Duration of exposure (in yrs since joined)		
<5	23	38.3
>5	36	60
Education		
Middle and secondary	22	36.6
Higher secondary	22	36.6
Graduate and above	16	26.6

Table III describes the self assessment of hearing ability by the traffic policemen.

Table IV depicts the distribution of the study subjects according to the usage of earplugs/ earmuffs.

TABLE III: Distribution of study subjects according to assessment of hearing status.

Characteristics	*Number*	*Percentage*
Quality of hearing		
Excellent	4	6.66
Above average	45	75
Average	9	15
Below average	2	3.33
Hearing over phone		
Without difficulty	47	78.33
Do miss some conversation	13	21.66
Hearing in crowd		
Without difficulty	45	75
Do miss some conversation	15	25
Sound of TV/radio		
Usually louder	7	11.66
Usually same loudness	53	88.33
Do people often indicate that you are talking too loudly?		
Yes	6	10
No	54	90
Do people often indicate that you talk too loudly?		
Yes	4	6.66
No	56	93.33
Tinnitus		
More than once a day- work related/recreational	11 work related	16.66

TABLE IV: Distribution of study subjects according to the use of earplugs/earmuffs.

Characteristics	*Number*	*Percentage*
Ever used earplugs or earmuffs		
No	60	100
Reason for non-usage		
Not available	60	100
Other personal protective equipments		
Hands	1	0.16
Cotton	4	6.66
Don't use anything	55	91.66
Do these PPEs effective if used?		
Yes	60	100

DISCUSSION

The minimum standard noise for noise pollution in the environment is 55 dB (1) but most of the traffic junctions in this study measured >75 dB of sound pressure level for which traffic policemen were exposed for >8 hrs per day. In the present study, 3.33% of subjects felt that their hearing ability was below average. A similar study among traffic cops in Gujarat showed that 2.3% of the subjects felt that their hearing ability was below average (2). Study conducted on Moscow traffic policemen showed that the working conditions correlate with hearing loss, so hearing loss in these traffic policemen working on roads is occupational and requires adequate prophylactic and therapeutic management (11). 81.2% traffic branch personnel of Pune traffic police showed sensorineural hearing loss (12). The main cause of stress as perceived by the traffic constables of Kolkata was excessive number of vehicles ie., 50% (13). 24% of Dhaka traffic police personnel showed mild to moderate sensorineural hearing loss due to noise exposure which is related with 6-10 years of duration of exposure (14). Study conducted on Cairo traffic policemen showed that the mean hearing threshold was significantly higher in traffic policemen exposed than that of the controls (15). One more study in Maharashtra showed that 84% of the sample reported hearing loss and defined at least some difficulty in hearing by one/both the ears (16). The self assessed prevalence of reduced hearing was found only in two (3.33%) subjects. Exact figures can be calculated by doing audiometry of these subjects. Thus on the basis of the findings of this study, it is recommended that the periodic medical examination should be done for the traffic policemen and it should include audiometry to assess the auditory effects of exposure to noise.

The study also revealed that most of the traffic police did not use any personal protective equipment (PPEs) like earplugs/ armuffs and the non-availability of these PPEs (100%) is the common reason for it. Most of the study subjects are in the economically productive age groups and if they suffer from hearing disability at this age, they would have to live with that disability throughout their life and if effective measures are taken at this stage, health hazards could well be prevented. Thus it is suggested that not only should these PPEs be made available, but also periodic workshops should be carried out to motivate the subjects for their correct and regular usage. The effectiveness of the PPEs over other methods to reduce noise exposure should also be demonstrated (17).

With this background, some preventive modalities for hearing conservation in the form of safety equipment and duty scheduling for exposure limitation can be suggested.

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A STUDY OF AUTONOMIC NERVOUS SYSTEM STATUS IN CHILDREN OF ASTHMATIC PARENTS

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Abstract : Asthmatic patients are known to have autonomic abnormalities. This study evaluated the status of autonomic nervous system in children of asthmatic parents for any occurrences of autonomic abnormalities that are known to occur in asthma. In this study autonomic function tests were conducted in children (5 to 10 years of age) divided into two groups: Group A had children from non-asthmatic parents as Control Group and Group B had children from asthmatic parents as Test Group. Both the groups had healthy children showing no clinical signs and symptoms of asthma, allergy or any illness known to affect autonomic nervous system. In response to various parasympathetic function tests (S/L ratio, 30:15 ratio, valsalva ratio and tachycardia ratio) and sympathetic function tests (handgrip test and cold pressor test) done, the two groups did not show any statistically significant dissimilarity for any of the parameters. The results of our study showed that there were no autonomic abnormalities found in the children of asthmatic parents. Thus this study indicates that the autonomic defects seen in asthmatics could be secondary to asthma and not because of autonomic aberrations inheritance in asthmatics as shown by earlier few studies supporting the possible role of inherited automatic reactivity in the pathogenesis and progression of asthma.

Key words : autonomic function tests asthmatics autonomic abnormalities inheritance autonomic reactivity

INTRODUCTION

The human airways are innervated by autonomic nerves, which regulate many aspects of airway function via its effects on smooth muscle tone, mucus secretion, microvascular permeability, blood flow, migration of inflammatory cells and release inflammatory mediators from them. Thus, autonomic nerves can influence airway calibre (1, 2, 3).

Airways are innervated by four nervous systems: cholinergic, adrenergic, inhibitory nonadrenergic non-cholinergic (i-NANC) and excitatory NANC (e-NANC). Dysfunction or hyperfunction of these systems may be involved in inflammation or hyper-

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responsiveness observed in asthmatic patients. Thus, several types of autonomic defects have been proposed in asthma; enhanced cholinergic, α-adrenergic, excitatory non-adrenergic non-cholinergic (e-NANC) bronchoconstrictor mechanisms and reduced β-adrenergic and inhibitory NANC (i-NANC) bronchodilator mechanisms (4).

Genetic factors are also known to influence not only the occurrence but also the severity of asthma. It has been found that a child's asthma or wheezing is highly associated with mother's or father's asthma, other atopic condition in mother, father or with other siblings. Many of the siblings of asthmatic children who were apparently normal with no overt clinical symptoms of asthma have positive exercise result and are prone develop asthma later in life (5, 6).

The present study has therefore been taken to investigate autonomic nervous system status in children of asthmatics. As any autonomic nervous system dysfunction in such children may make them more prone to develop asthma under unfavourable circumstances.

METHODS

This study was conducted in 60 children (5 to 10 years) divided into two groups: 'Test Group' had 30 healthy children of asthmatic patients that were selected from Asthma clinic of Lok Nayak Jay Prakash Narayan Hospital, New Delhi. 'Control group' had age matched 30 healthy children from non-asthmatic parents, who were non-teaching staff of Maulana Azad Medical College, New Delhi.

Inclusion criteria for test group: The children included in test group had either one or both the parents with moderate to severe persistent asthma diagnosed by the asthma clinic following NHLBI guidelines, with duration of more than three years.

Exclusion criteria for both test and control group: Children suffering from asthma, allergy or any other illness known to affect the functioning of autonomic nervous system.

All subjects were tested under similar laboratory conditions. Subjects were allowed to acclimatize themselves to experimental and environmental conditions for one hour, as anxiety or stress can affect autonomic function. During this period detailed history and medical examination was conducted with parents help and nature of tests was explained to both parents and children to allay their apprehension. The investigative procedures included two types of measurements : the anthropometric measurements and the autonomic function tests. The tests done are as follows :

Anthropometric tests

1. Height (in cms): was measured using Park's anthropometric scale. The range of the scale used was 140-190 cm and sensitivity was 0.5 cm.
2. Weight (in kgs): was recorded using Avery machine. It had maximum measuring capacity of 120 kgs and sensitivity of 0.05 kgs.
3. Body Mass index (kg/m^2) was calculated using Quetelet's index. ($BMI = Wt./(Ht)^2$.

Autonomic function tests

The following standard autonomic function tests were conducted with the help of an ECG machine, Model CARDIART- 406 (BPL product) with automode feature. A standard limb lead II was recorded and R-R intervals were calculated manually.

Standing to Lying Ratio: The standard procedure was followed to conduct this test and S/L ratio was calculated as per Rodrives and Ewing's method (7):

$$S/L\ Ratio = \frac{\text{Longest R-R interval during 5 beats before lying down}}{\text{Shortest R-R interval during 10 beats after lying down}}$$

30:15 Ratio: Following the standard procedure for this test, this ratio is calculated as given below.

$$30:15\ Ratio = \frac{\text{R-R interval at beat 30}}{\text{R-R interval at beat 15}}$$

Valsalva ratio

Standard procedure for the test was performed.

$$\text{Valsalva Ratio} = \frac{\text{Maximum R-R interval after the strain}}{\text{Shortest R-R interval during the strain}}$$

Tachycardia ratio (9)

It was computed from ECG recorded in above mentioned procedure of valsalva manoeuvre.

$$\text{Tachycardia ratio} = \frac{\text{Shortest R-R interval during the strain}}{\text{Longest R-R interval before the strain}}$$

Hand grip test

This test was done with the help of hand grip dynamometer (product of Dr. Reddy's lab) specially designed for children between 5-10 years of age with upper limit of 10 kgs. The upper limit of 10 kgs was deduced by conducting a small pilot study for maximum voluntary effort for 5-10 year old children. The highest rise in the diastolic blood pressure during test is taken as an index of response to hand grip (10).

Cold pressor test

After following the standard procedure of the test, maximum increase in systolic and diastolic blood pressure was determined and results recorded. In any condition where there is deficient sympathetic outflow the cold pressor test will be expected to show a smaller rise (11).

Statistical analysis

For each variable group, the mean and standard deviation were calculated according to accepted statistical methods. Intergroup mean difference was tested for significance by applying unpaired Students 't'-test.

RESULTS

The physical characteristics of various groups are given in Table I, it can be seen that there is no significant difference between age, height, weight, and body mass index (BMI) among the two groups.

Statistical analysis was carried out by applying Students "t" test. The resultant p value for the mean difference between the two groups was found to be higher than 0.5, thus suggesting that the two groups are anthropometrically similar.

Autonomic function tests

Various autonomic function tests performed were standing to lying ratio (S/L ratio), lying to standing ratio (30:15 ratio), valsalva ratio, tachycardia ratio, hand grip test (HGT) and cold pressor test (CPT).

The results of the above tests are depicted in table 1. The data reveals that mean value for S/L ratio and valsalva ratio was found to be slightly higher in Controls than that in Tests. And in HGT, the change in SBP from rest is slightly higher in Tests, while the change in DBP was found to be lower in Tests as compared to that in Controls. In

TABLE I

Parameters	*Tests (n=30)* Mean±SD	*Controls (n=30)* Mean±SD	*P value*
Age (Years)	9.10±1.79	9.23±1.36	>0.5
BMI (kg/m^2)	13.39±3.99	15.3±1.67	>0.5
HR (beats/min)	80.3±8.41	78.63±6.47	>0.5
S/L Ratio	1.05±0.15	1.11±0.13	>0.5
30:15 Ratio	1.12±0.18	1.11±0.09	>0.5
Valsalva ratio	1.45±0.29	1.50±0.30	>0.5
Tachycardia ratio	0.699±0.18	0.701±0.12	>0.5
HGT	Δ SBP 12.29±6.02	Δ SBP 11.53±4.97	>0.5
(in mmHg)	Δ DBP 17.14±6.14	Δ DBP 18.47±4.44	>0.5
CPT	Δ SBP 16.63±8.61	Δ SBP 22.7±4.91	>0.5
(in mmHg)	Δ DBP 16.48±6.88	Δ DBP 12.57±4.34	>0.5

BMI: Basal Metabolic Index
HR: Heart Rate
CPT: Cold Pressor Test
DBP: Diastolic Blood Pressure
S/L Ratio: Standing to Lying Ratio
HGT: Hand Grip Test
SBP: Systolic Blood Pressure
Δ: Change from Basal Blood Pressure

case of CPT the change in SBP from rest was quite lower in Tests, while the change in DBP was higher in Tests as compared to that in Controls.

The results from the statistical analysis done for the two groups using “t” test reveal that the difference in mean values for various parameters between two groups is statistically insignificant.

DISCUSSION

The bulk of evidence indicates that the patients with asthma have both increased cholinergic and α_1-adrenergic sensitivity in conjunction with reduced β_2 adrenergic responses (4). These abnormalities also tend to increase bronchial smooth muscle tone, increase mucous secretion, increase release of inflammatory mediators from mast cells and increase release of proteolytic enzymes from inflammatory cells. All of these results would clearly be deleterious in obstructive pulmonary diseases (12, 13, 14, 15, 16).

Whether these autonomic aberrations contribute to pathophysiology of asthma or they are the result of disease process is an important question. The studies of Kaliner etal (17, 18) show a clear correlation between α-adrenergic hypersensitivity and β-adrenergic hyposensitivity and airway reactivity as assessed by methacholine challenge. This is inferred evidence that inborn abnormalities in autonomic reactivity are risk factors for increased airway reactivity. In epidemiological studies, the airway reactivity has been shown to be one of the risk factors for development and progression of obstructive pulmonary disease (19, 20). Thus these studies support the hypothesis that the autonomic reactivity might predispose to development and progression of obstructive pulmonary disease. However, there is some additional interaction with environmental factors (allergens, infection or irritants such as cigarette smoke) or with other genetic traits is necessary in order for the disease to occur.

If these hypotheses are true, the first degree relatives of persons with clear

autonomic abnormalities (such as allergic asthma patients) will also have demonstrable asthma symptoms and a subgroup of patients with obstructive pulmonary disorders (such as intrinsic asthma and chronic bronchitis/ emphysema) will also have abnormal autonomic reactivity. All of these predictions can be tested experimentally.

Nothing much has been done in this regard specially in asthma. Interestingly, a similar study has been done by Davis & Kaliner (21) in cystic fibrosis where it was found that the autonomic abnormalities present in cystic fibrosis which are similar to those present in asthma (increased α-adrenergic and cholinergic responsiveness and decreased β-adrenergic responsiveness) also occur in asymptomatic heterozygotes for cystic fibrosis (parents of patients). So it was suggested that autonomic abnormalities may be inherited characteristic and not secondarily acquired.

Therefore the present study is an endeavour to reveal similar findings in case of asthma. In our study, we have taken non-asthmatic children whose at least one parent is asthmatic, as their first degree relatives and have assessed their autonomic nervous system status by comparing it with controls (children of non-asthmatic patients).

The autonomic function tests show that the mean value for 30:15 ratios was higher in children of asthmatic parents, while for S/L ratio, valsalva ratio, and tachycardia ratio is higher in controls. But statistical significance could not be established for any of these parameters. For the handgrip test, the mean Δ SBP was found to be higher, while Δ DBP was found to be lower in Tests as compared to that in Controls. For the cold pressure test, the mean Δ SBP was found to be lower, while Δ DBP was found to be higher in Tests as compared to that in Controls. No statistical significance could be established after analysis for any of the tested parameters for sympathetic tests.

The results of our study reveal that no autonomic abnormalities were found in the children of asthmatic parents that are not in accordance with the above mentioned hypothesis (Abnormal autonomic reactivity might predispose to development and progression of obstructive pulmonary disease). Though such children are prone to develop asthma but it would be due to hereditary and other factors and not due to autonomic abnormalities. Above study is also not in accordance with the cystic fibrosis study (The study suggested the autonomic abnormalities may be inherited characteristics and not secondarily acquired) as no autonomic abnormalities were found in these children whose asthmatic parents do have autonomic abnormalities. So our study goes in favour of the possibility that the autonomic aberrations present in asthma are not inherited and are developed secondary to the disease process of asthma.

Therefore results of our study conclude that no autonomic abnormalities are found in children of asthmatic parents and the autonomic defects found in asthmatics are developed secondary to disease process. Hence, it does not favour the possibility that these autonomic aberrations present in asthma being inherited and having a possible role in pathogenesis and progression of asthma.

For future studies it would be highly acceptable if simultaneous PFT is also done in such children to know their bronchial lability. PFT tests would further corroborate the findings and conclusions of the study. Moreover, a follow-up would be ideal in such

children till their adulthood to reveal any ANS imbalance or asthma if developed later. A similar study can also be conducted in the children whose both parents are asthmatics, as in such cases chances of developing asthma are of higher degree. Such studies may give more definitive conclusions on the nature of ANS abnormalities in asthma being primary or secondary to the disease process.

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INFLUENCE OF DEEP BREATHING EXERCISE ON SPONTANEOUS RESPIRATORY RATE AND HEART RATE VARIABILITY : A RANDOMISED CONTROLLED TRIAL IN HEALTHY SUBJECTS

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Abstract : Studies show that yogic type of breathing exercises reduces the spontaneous respiratory rate. However, there are no conclusive studies on the effects of breathing exercise on heart rate variability. We investigated the effects of non-yogic breathing exercise on respiratory rate and heart rate variability. Healthy subjects (21-33 years, both genders) were randomized into the intervention group (n=18), which performed daily deep breathing exercise at 6 breaths/min (0.1 Hz) for one month, and a control group (n=18) which did not perform any breathing exercise. Baseline respiratory rate and short-term heart rate variability indices were assessed in both groups. Reassessment was done after one month and the change in the parameters from baseline was computed for each group. Comparison of the absolute changes [median (inter-quartile ranges)] of the parameters between the intervention and control group showed a significant difference in the spontaneous respiratory rate [intervention group –2.50 (–4.00, –1.00), control group 0.00 (–1.00, 1.00), cycles/min, $P<0.001$], mean arterial pressure [intervention group –0.67 (–6.67, 1.33), control group 0.67 (0.00, 6.67), mmHg, ($P<0.05$)], high frequency power [intervention group 278.50 (17.00, 496.00), control group –1.00 (–341.00, 196.00), ms^2 $P<0.05$] and sum of low and high frequency powers [intervention group 512.00 (–73.00, 999.00), control group 51.00 (–449.00, 324.00), ms^2, $P<0.05$]. Neither the mean of the RR intervals nor the parameters reflecting sympatho-vagal balance were significantly different across the groups. In conclusion, the changes produced by simple deep slow breathing exercise in the respiratory rate and cardiac autonomic modulation of the intervention group were significant, when compared to the changes in the control group. Thus practice of deep slow breathing exercise improves heart rate variability in healthy subjects, without altering their cardiac autonomic balance. These findings have implications in the use of deep breathing exercises to improve cardiac autonomic control in subjects known to have reduced heart rate variability.

Key words : heart rate variability, breathing exercise, respiratory rate, cardiac autonomic tone, spectral power

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INTRODUCTION

Heart rate variability (HRV) is a measure of the extent of modulation of the cardiac sympathetic and parasympathetic tones and increased HRV is a marker of healthy cardiac autonomic activity (1). Respiration modulates the autonomic flow to the heart as evidenced by respiratory sinus arrhythmia and contributes to HRV (2). Respiratory sinus arrhythmia (3) and HRV (4, 5, 6) have been found to increase in magnitude with voluntary decrease in respiratory rate and to reach a maximum at 0.1 Hz (6 breaths/ min).

A few researchers have reported that the resting respiratory rate can be modified to a lower rate by the practice of yogic breathing exercises (7, 8), but no investigation has been done to study the changes in HRV due to such a decrease in spontaneous respiratory rate. Simple, deep slow breathing exercises are often advocated as a method of relaxation. Would the daily practice of such non-yogic, deep slow breathing exercise also reduce the spontaneous breathing rate? If so, what would be its effect on the HRV? Addressing these questions, we subjected healthy volunteers to regular deep slow breathing exercise for a month and compared their respiratory rates and HRV indices before and after the breathing training.

MATERIALS AND METHODS

Participants

Subjects were enlisted from the faculty members, their spouses and from the postgraduates of the Institution, who volunteered in response to the notice advertising for volunteers for the study. Healthy volunteers of both genders, aged 21 to 33 years, with BMI of 19 to 25 kg/m^2 and physical activity levels of sedentary to moderate as per a questionnaire (9) were recruited to the study. All the subjects were non-smokers and were not on any medications. Those already performing some form of yoga or breathing exercises were excluded from the study. Those with Diabetes and cardiovascular diseases were also excluded from the study. All the female subjects had regular menstrual cycles of normal duration and none of them were on oral contraceptives. The study was prior reviewed and approved by the Institutional Review Board of Christian Medical College, Vellore. Each subject gave a written informed consent prior to randomization into the intervention or control group of the study.

Experimental design

Randomised controlled trial (Registry number : CTRI/2011/091/000078)

After recruitment into the study, subjects were assigned prospectively by randomization in a 1:1 ratio into the Intervention group or the Control group of the study. The randomization was done by referring to a computer generated randomization list, prepared using block randomization method with a variable block size of 2, 4 and 6. The details of the allocation sequence were contained in a set of sealed opaque envelopes and were not known to the investigators who enrolled the participants.

A sample size of 36 subjects (18 subjects in each group) was calculated based on the results of a pilot study done on similar subjects.

A total of 59 participants were assessed for eligibility, of which 42 were recruited based on the inclusion and exclusion criteria. These 42 participants were randomized into the intervention (22 subjects) and control (20 subjects) groups. Three subjects dropped out of the study from the intervention group and the data of one subject in the intervention group and 2 subjects in the control group were not considered for analysis due to technical and procedural errors.

Baseline assessments were done on the participants at the first visit to the laboratory. The same parameters were assessed again at the second visit, one month later. Subjects in both the intervention and control group were asked to continue with their existing level of physical activity during the period of one month of the study.

Intervention: Deep slow breathing exercise

The subjects in the intervention group were asked to perform simple, deep slow breathing exercise at 6 breaths per min, daily, for half an hour, for the duration of one month of the study. They were trained to perform this breathing exercise, such that each breathing cycle consisted of 4 seconds of inspiration and 6 seconds of expiration. They were then given an audio CD with the recorded commands, prompting the timed inhalation and exhalation. They could do the half hour breathing exercise either as one sitting or as two equally divided sittings, at any convenient time of the day, either in the sitting or in the supine position adopting any convenient posture. They were given a diary to maintain a record of their everyday training. Further, continual follow up of their daily breathing practice was done through repeated phone calls by the investigators.

The breathing exercise was given at 0.1 Hz since studies show that the modulatory effects of respiration are maximal at this breathing frequency (5, 6). Further, 0.1 Hz breathing has been reported to improve the baroreflex sensitivity and decrease the blood pressure in hypertensives (10), and improve oxygen saturation in chronic heart failure patients (8).

Expected outcomes

Change in the spontaneous resting respiratory rate was the primary outcome and changes in the Short-term HRV indices were the secondary outcome.

Acquisition of data

ECG and respiration signals were acquired using commercial leads, respiratory belt and amplifiers (BIOPAC Systems, Inc., CA 93117, USA) and stored in a personal computer. Blood pressure was recorded manually by a sphygmomanometer.

Baseline respiratory rate, heart rate, blood pressure and short-term HRV indices in the supine resting state were measured in the morning following 20 min of supine rest, 2-4 hours after a light breakfast. The subjects were asked to refrain from heavy physical activity for 24 hours and from consumption of alcohol and caffeinated beverages for 12 hours, prior to the measurements. Same parameters were assessed again in both groups at the end of one month of the study. Both the assessments were done in the same menstrual phase in all the female volunteers, except two.

HRV analysis

Published guidelines were followed for short-term HRV analysis (1). A 5-min recording of the lead II ECG, avoiding segments with ectopic beats, was subjected to short-term HRV analysis using HRV analysis software version 1.1 of the Biomedical Signal Analysis group, University of Kuopio, Finland (11). Standard time and frequency domain indices were computed.

The list of parameters studied under time domain analysis were mean (mean RR) and standard deviation (SDNN) of all the normal-to-normal RR intervals, as well as the root mean square of successive differences between adjacent RR intervals (RMSSD) and the percentage of number of RR intervals with differences >50 ms (pNN50).

RR interval data lengths of 256 seconds was cubic-spline interpolated, de-trended, Hanning windowed and fast-Fourier transformed using the averaging Welch's periodogram method to obtain the power spectral density. The frequency domain indices of low frequency (LF) and high frequency (HF) spectral powers were computed in ms^2 by integrating the power in the ranges of 0.04-0.15 Hz and 0.15-0.45 Hz respectively. The sum of the LF and HF powers was calculated as the LF+HF power. Normalized units of low (LF nu) and high (HF nu) frequency powers and the ratio of the low frequency to high frequency powers (LF/HF) were also computed under frequency domain analysis.

Statistical analysis

Study variables are presented as medians with interquartile ranges. Wilcoxan rank sum test was used to compare the absolute change in the various parameters between the two study groups (12). Spearman's correlation coefficient test was employed to study the extent of association between variables. A P-value of less than 0.05 was considered statistically significant. All statistical analyses were done using STATA 10.0 (StataCorp, College Station, Texas, USA).

RESULTS

The demographic characteristics of the intervention group (25.6±3.31 years, mean±SD; 7 males and 11 females; BMI of 21.9± 1.74 kg/m^2, mean±SD) and the control group (25.5±3.29 years, mean±SD; 11 males and 7 females; BMI of 21.7±1.30 kg/m^2, mean±SD) were similar.

Comparison of the absolute change [median (inter-quartile ranges)] in respiratory rate over time, showed a significant difference between the intervention and control group [intervention group –2.50 (–4.00, –1.00), control group 0.00 (–1.00, 1.00), cycles/min, P<0.001] (Table I).

Similarly, comparison of the absolute changes [median (inter-quartile ranges)] in the spectral powers over time, showed a significant difference across the two groups, with respect to high frequency power [intervention group 278.50 (17.00, 496.00), control group –1.00 (–341.00, 196.00), ms^2 P<0.05] and sum of low and high frequency powers [intervention group 512.00 (–73.00, 999.00), control group 51.00 (–449.00, 324.00), ms^2, P<0.05] (Table I). The absolute changes over time in LF/HF ratio and the LF nu and HF nu were not significantly different between the two groups.

TABLE I: Comparison of absolute changes in study variables between the Control and Intervention groups.

Parameters	*Control group n=18*	*Intervention group n=18*
Heart rate (bpm)		
Baseline, median (IQR)	66.87 (63.03, 70.40)	68.79 (61.93, 72.78)
Median change (IQR), baseline to a month later	–0.45 (-4.83, 4.53)	–0.07 (-5.73, 3.68)
MAP (mmHg)		
Baseline, median (IQR)	84.33 (80.00, 90.00)	82.00 (80, 86.67)
Median change (IQR), baseline to a month later	0.667 (0.000, 6.667)	–0.667 (–6.667, 1.333)*
Respiratory rate (min^{-1})		
Baseline, median (IQR)	17.00 (16.00, 18.00)	18.00(17.00, 20.00)
Median change (IQR), baseline to a month later	0.00 (–1.00, 1.00)	–2.50 (–4.00, –1.00)***
Mean RR (sec)		
Baseline, median (IQR)	0.90 (0.86, 0.96)	0.88 (0.83,0.97)
Median change (IQR), baseline to a month later	0.01 (-0.06, 0.09)	0.01 (–0.04, 0.07)
SDNN (sec)		
Baseline, median (IQR)	0.06 (0.04, 0.08)	0.06 (0.05, 0.07)
Median change (IQR), baseline to a month later	0.01 (–0.01, 0.01)	0.01 (–0.00, 0.02)
pNN50 (%)		
Baseline, median (IQR)	31.20(9.80, 46.80)	30.55 (14.60, 45.20)
Median change (IQR), baseline to a month later	–1.50 (–17.00, 12.00)	10.00 (–20.00, 52.00)
RMSSD (ms)		
Baseline, median (IQR)	56.45 (31.40, 73.10)	56.35 (36.00, 71.20)
Median change (IQR), baseline to a month later	0.15 (–10.30, 8.90)	6.95 (–9.90, 17.10)
LF power (ms^2)		
Baseline, median (IQR)	343.50 (170.00, 653.00)	352.00 (209.00, 733.00)
Median change (IQR), baseline to a month later	74.50 (-110.00, 188.00)	252.50 (5.00, 486.00)
HF power (ms^2)		
Baseline, median (IQR)	758.00 (184.00, 1294.00)	505.00 (310.00, 873.00)
Median change (IQR), baseline to a month later	–1.00 (-341.00, 196.00)	278.50 (17.00, 496.00)*
LF+HF power (ms^2)		
Baseline, median (IQR)	1398.50(362.00, 1764.00)	1031.50 (541.00, 1351.00)
Median change (IQR), baseline to a month later	51.00 (-449.00, 324.00)	512.00 (–73.00, 999.00)*
LF nu		
Baseline, median (IQR)	40.10(27.50, 51.60)	45.65 (28.30, 63.30)
Median change (IQR), baseline to a month later	–0.60 (-4.90, 8.00)	2.95 (–11.30, 10.70)
HF nu		
Baseline, median (IQR)	59.90 (48.40, 72.50)	54.35 (36.70, 71.70)
Median change (IQR), baseline to a month later	0.60 (–8.00, 4.90)	–2.95 (–10.70, 11.30)
LF/HF		
Baseline, median (IQR)	0.68(0.38, 1.06)	0.84 (0.40, 1.73)
Median change (IQR), baseline to a month later	–0.06 (–0.15, 0.22)	0.01 (–0.37, 0.32)

Values are given as median (IQR) – median (inter-quartile range). *P<0.05, ***P<0.001. Wilcoxan rank sum test.

Absolute changes of the time-domain parameters over the one month study period were not significantly different between the groups.

There was no correlation between the observed changes in respiratory rate and LF+HF power in the intervention group (Spearman's correlation coefficient 0.27, P=0.21).

A significant difference was observed in

the absolute changes of mean arterial pressure (MAP) between the two groups [intervention group –0.67 (–6.67, 1.33), control group 0.67 (0.00, 6.67), mmHg, ($P<0.05$)].

DISCUSSION

We compared the effect of one month of daily deep slow breathing exercise in the intervention group versus nil intervention in the control group. The outcome of the study was a significant decrease in spontaneous resting respiratory rate and an increase in the spectral indices of short-term HRV as a result of the deep breathing exercise.

It is well established that LF power reflects modulation of sympathetic tone with contribution from the parasympathetic tone, while HF power reflects the modulation of parasympathetic tone alone (13). Our findings indicate that the breathing exercise increased the modulation of the parasympathetic tone and the total resting modulation of the cardiac autonomic tones. Absence of changes in mean RR, LF/HF ratio and the LF nu and HF nu implies that the breathing exercise increased the variability without altering the proportion of the two cardiac autonomic tones and the sympatho-vagal balance.

The resting respiratory rate reduced in all the subjects of the intervention group except one, in whom the rate remained the same. In 2 subjects it decreased to 9 breaths per min and below. Two previous studies, one in heart failure patients (8) and the other in seasoned yoga practitioners (7) have reported similar findings but both involved yogic type of breathing exercises. Yogic breathing exercises involve adapting certain bodily postures along with mental focus on the breath. Unlike these studies, we employed a simple deep slow breathing training, in which normal healthy subjects increased their tidal volumes and decreased their respiratory rates voluntarily to 6 breaths per minute, without adhering to any specific body posture or mental focus.

Previous studies have reported an automatic adjustment in tidal volumes during voluntary paced breathing at different frequencies (5). Therefore, to maintain alveolar ventilation, the tidal volume of the subjects in the intervention group would have increased during breathing training at 0.1 Hz and also when the spontaneous rates decreased after a month of training. This rationale is in keeping with the well-described inverse relationship between tidal volume and respiratory rate to maintain constant alveolar ventilation (14). It is also well known that pulmonary stretch receptor inputs and chemoreceptor inputs feed back to the medullary respiratory centres (15). It may be postulated that during the deep breathing exercise these two inputs get exaggerated due to the increased tidal volume and the larger than normal oscillations in the arterial PO_2 and PCO_2, leading to entrainment of the central respiratory neurons and a re-setting of the respiratory rhythm. Similarly, the mechanisms producing sinus arrhythmia would have been operating at an exaggerated level during the deep breathing exercises. This would have resulted in increased modulation of the cardiac autonomic tones leading to increased HRV.

To the best of our knowledge our study

is the first to report an increase in HRV due to the practice of deep slow breathing exercises. In the studies done by Sanderson et al. (4) and Cooke et al. (5), short-term HRV parameters were found to increase when the respiratory rate was decreased voluntarily. In our study, a decrease in spontaneous breathing rate is associated with increased spectral indices of HRV. However, absence of correlation between the extent of decrease in respiratory rate and the increase in LF+HF power implies that deep breathing exercise increased the HRV spectral indices independent of the decrease in respiratory rate. The LF+HF power was chosen to study the association, since there would have been transference of power from the HF to the LF range in two of the subjects in whom the respiratory rate had decreased to 9 breaths per min (0.15 Hz) and below.

Deep slow breathing exercises are recommended as a relaxation technique and to reduce the arterial blood pressure in hypertensive patients (10, 16). In our study there was a minimal, but nevertheless significant, decrease in the MAP of the intervention group compared to the control group, attributable to the deep breathing exercise of one month. Further, the results of our study suggest that deep slow breathing exercises may also be recommended to increase the HRV in healthy subjects. Increased HRV is a marker of improved cardiac autonomic regulation and has been linked to increased longevity (17).

A limitation of our study is that though there was a significant increase in the spectral indices of HRV, a corresponding change in the time domain parameters was not observed. However, as per published recommendations, spectral indices have better interpretable results in terms of cardiac autonomic regulation than time domain indices in short-term HRV analysis (1). Further, the increase in HRV spectral indices due to the breathing exercise observed in our study was not of large magnitude. This is probably because of the very high baseline levels of HRV in the young and healthy subjects recruited in our study.

Published literature reports that HRV is reduced with ageing (18), stress (19, 20) and in certain disease conditions (1). Would the practice of deep slow breathing exercise in such situations help to increase the HRV and improve the cardiac autonomic status associated with the condition ? Adams et al. (21) have reported that the daily practice of breathing at 6 breaths/min did not alter the HRV parameters in post myocardial infarction or coronary artery bypass graft surgery patients. However, the control and intervention group of patients in their study were in an ongoing cardiac rehabilitation programme, which would have altered the HRV in both the groups. Further, 77% of the patients in their study were on heart rate lowering medications which could have prevented the manifestation of the beneficial effects of breathing exercises. The authors themselves have stated these limitations of their study.

Our study confirms that simple deep slow breathing exercise, without any associated yogic practices, decreases spontaneous respiratory rate and increases the spectral indices of short-term HRV. Further studies on an elderly population or on individuals known to have reduced HRV due to stress or disease are warranted to explore the

effects of deep slow breathing exercises in improving cardiac autonomic control in such situations.

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EFFECT OF BODY MASS INDEX ON PARAMETERS OF NERVE CONDUCTION STUDY IN INDIAN POPULATION

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Abstract : As the adipose tissue in epineurium is related to some extent to amount of body fat, it is possible that the amount of such fat may affect the nerve conduction. In this study, we have analyzed effect of Body Mass Index (BMI) on various parameters of nerve conduction study in one hundred seventy five healthy volunteers between ages of 18 and 66 years. BMI was determined and nerve conduction studies were performed prospectively in all the subjects using standardized techniques. Prolongation of distal motor latency (DML) was observed with increasing BMI except in motor Peroneal nerve. (In Median Nerve, $P<0.05$). F- Wave minimum latency was also found to be significantly prolonged in ($P<0.05$) in motor Tibial nerve. Higher BMI was found to be non-significantly associated with lower amplitude (both sensory and motor) except for peroneal nerve. Motor as well as sensory conduction velocity showed non-significant slowing along increasing BMI except sural and motor-sensory ulnar nerve in younger age group. This study demonstrated that various parameters of nerve conduction study can be affected by BMI. So, this biological factor has to be taken into consideration while interpreting nerve conduction studies.

Key words : conduction velocity, nerve conduction study, body mass index, distal motor latency, amplitude

INTRODUCTION

Nerve conduction study helps in differentiating two major groups of peripheral nerve diseases – demyelination and axonal degeneration. It helps to delineate the extent and distribution of neural lesion (l). High and low body mass index (BMI) have been reported as risk factor for ulnar neuropathy at elbow and high BMI as risk factor for carpel tunnel syndrome (2). BMI was also found to have negative correlation with sensory nerve action potential amplitude (3). In assessment of diabetic peripheral neuropathy, BMI is very important factor to be taken into consideration (4). Thus, influence of BMI on nerve conduction study is crucial which has

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to be taken into consideration while interpreting nerve conduction studies. Several studies (5-7) evaluated influence of age, height and BMI on nerve conduction velocity, however, majority of these studies are based on Caucasian subjects. Currently the same normative values are used both for thin and obese subjects during interpretation of nerve conduction study. As the adipose tissue in epineurium may be related to some extent to amount of body fat (8), it is reasonable that the amount of such fat may affect the nerve conduction. While using normative reference data for making diagnosis, it is preferable to have these data derived on a population that closely relate in demographic profile to the patients being studied. Therefore, this study is aimed at studying the effect of BMI on nerve conduction parameters among healthy Central Indian rural subjects.

MATERIALS AND METHODS

One hundred seventy five healthy volunteers between ages of 18 and 66 years were included in the study after getting their informed written consent to participate. All participants were examined to exclude history of systemic or neuromuscular disorders. Relevant clinical history was taken and neurological examination was done. Subjects were excluded if reported a history of neuropathy, limb injury or ulcer, neuromuscular transmission disorder, myopathy and alcohol abuse. Institutional Ethics Committee's approval was obtained and study was conducted at fixed room temperature of 30°C.

Electrophysiological methods

For all subjects the following were recorded: age, sex, height (in cm), and weight (in kg). Body mass index (BMI) was calculated as weight divided by height in meters square (kg/m^2). Nerve conduction study was done on RMS EMG EP Mark-II. For motor nerve study, duration was kept at 200 µs, filter was between 2 Hz to 10 KHz and sweep speed was 5 ms/D for lower limb and at 100 µs, 2 Hz-5 KHz, 5 ms/D respectively for upper limb. For sensory nerve study, duration was 100 us, sweep speed 2 ms/D and filter was between 20 Hz to 3 KHz. Motor nerve tested were Median, Ulnar, Peroneal, Tibial and sensory study was done on Median, Ulnar and Sural nerve. Parameters studied for motor nerves were distal motor latency (DML), amplitude and conduction velocity (CV) whereas for sensory nerves were amplitude and conduction velocity. The sites of stimulation for motor Peroneal, Tibial nerves were ankle and at or below popliteal fossa and recording site were motor point of Extensor digitorum brevis and Abductor Hallucis respectively. Reference electrode was placed 4 cm distally over 4th metatarso-phalangeal joint for peroneal nerve and over 1st metatarso-phalangeal joint for Tibial nerve. The site of stimulation for motor median, ulnar nerves were the wrist and elbow and recording site were motor point of abductor pollicis brevis and abductor digiti minimi respectively. Reference electrode was placed 4 cm distally over the 1st metacarpo-phalangeal joint for median nerve and over 5th metacarpo-phalangeal joint for ulnar nerve. Belly tendon montage was used with cathode and anode 3 cm apart. For sensory nerves, antidromic study was done. Sensory nerve action potential amplitude was taken from peak to base. Ground electrode was placed between stimulating and recording electrodes. Recording surface disc electrode

was placed below lateral malleolus of ankle for sural nerve.

F-wave study involved supramaximal stimulation of motor nerves. A large compound muscle action potential (CMAP) followed by small irregular shaped CMAPs were elicited. Minimum 10 stimuli were passed to obtain F-wave on raster scale and minimum F-wave latency (F-min lat) was noted. For F-wave, setting was done as duration of 100 us, sweep speed of 10 ms/D and filter was between 2 Hz to 10 KHz.

Statistical methods

Statistical analysis was done using Statistical Package for Social Sciences (SPSS) 10.0 version. Values obtained were expressed in the form of mean and standard deviation (SD). Data has been presented in three groups of BMI. Inter-group comparison of data between three groups of BMI has been done. Analysis of data was done by one-way ANOVA and post-hoc by Tuky-Krammer test. P value was taken as significant if found to be less than 0.05.

RESULTS

One hundred seventy five volunteers aged 18-66 years (mean BMI 20.58±3.02) were included in the study. BMI ranged from 13.49 to 27.08 kg/m^2. There was 144 males (mean

TABLE I: Body Mass Index wise distribution in younger age group (18-45 years) [Right side].

Nerve	*Parameters*	*BMI in wt/ht m²*			*P value*
		<18	*18-22.9*	*23-27.9*	
Motor Median	DML	3.13±0.47	3.16±0.49	3.39±0.48	0.038*
	AMP	14.34±4.28	13.87±3.81	14.41±4.21	0.738
	CV	56.54±4.14	56.47±4.77	57.10±4.58	0.778
	F-Min	25.80±2.35	25.55±2.12	26.17±1.73	0.340
Motor Ulnar	DML	2.29±0.44	2.27±0.29	2.31±0.47	0.899
	AMP	13.46±3.24	12.98±2.58	13.43±2.82	0.593
	CV	58.10±5.23	58.54±4.50	58.63±4.91	0.872
	F-Min	26.29±2.72	26.34±2.61	26.75±1.79	0.653
Motor Tibial	DML	3.57±0.63	3.64±0.81	3.69±0.68	0.767
	AMP	20.79±6.36	18.71±6.21	19.04±5.35	0.226
	CV	50.04±3.83	49.24±3.75	49.48±3.54	0.569
	F-Min	43.75±3.89	45.37±3.99	46.90±2.93	0.002*
Motor Peroneal	DML	4.28±0.71	4.10±0.74	4.15±0.66**	0.448
	AMP	7.22±2.45	8.23±3.15	8.49±2.95	0.144
	CV	52.07±4.98	51.82±4.48	51.82±5.00	0.961
	F-Min	42.64±3.51	43.34±4.34	43.61±3.24	0.543
Sensory Median	AMP	41.21±13.87	38.42±13.50	36.14±12.19	0.267
	CV	59.31±5.04	59.48±5.57	58.24±6.37	0.536
Sensory Ulnar	AMP	32.39±17.20	28.29±12.75	26.71±12.44	0.190
	CV	57.85±7.61	58.01±6.34	59.92±6.48	0.302
Sensory Sural	AMP	20.96±9.66	19±9.77	19.01±6.52*	0.528
	CV	51.43±5.88	51.76±6.55	52.10±5.66	0.896

Nerve conduction was also performed in left side limbs, and data was similar to that of right side. Data presented are mean±SD. Analysis of data was done by one-way ANOVA and post-hoc by Tuky-Krammer test. The ** depicts comparison of BMI < 18 with BMI 23–27.9. *P<0.05; **P<0.05.

MNCS: motor nerve conduction studies; SNCS: sensory nerve conduction studies; DML: distal motor latency in millisecond; AMP: amplitude in mV (motor nerve); in µV (sensory nerve); CV: conduction velocity in m/s; F-Min: F-min latency in millisecond; BMI: Body Mass Index.

BMI 20.62±2.85 kg/m^2) and 31 women (mean BMI 20.44±3.74 kg/m^2). Descriptive statistics of BMI wise distribution for right sided motor and sensory nerves in younger (18-45 years) and older age groups (46-66 years) are shown in Tables I and II. Nerve conduction was also performed on left side limbs and as the data was similar to that of right side; only right sided values were depicted. In both age groups, prolongation of distal motor latency (DML) was observed with increasing BMI except in motor Peroneal nerve. (In Median Nerve, P<0.05). F-wave minimum latency was also found to be significantly prolonged in (P<0.05) in motor Tibial nerve, however ,in rest of the tested nerves, similar finding is non-significant in younger age group. In older age group, F-wave minimum latency showed non-significant decrease with increasing BMI in Peroneal and Tibial nerve. In both younger and older age group, higher BMI was found to be non-significantly associated with lower amplitude (both sensory and motor) except for peroneal nerve. However magnitude of decrease of amplitude on sensory side is greater as compare to motor side. Motor as well as sensory conduction velocity (CV) showed nonsignificant slowing along increasing BMI except in sural and motor-sensory ulnar nerve in younger age group, however, in older age group conduction velocity was found to be increasing with higher BMI (motor ulnar nerve, P<0.05).

TABLE II: Body Mass Index wise distribution in older age group (46-66 years) [Right side].

Nerve	*Parameters*	*BMI in wt/ht m²*			*P value*
		<18	*18-22.9*	*23-27.9*	
Motor Median	DML	3.23±0.51	3.53±0.42	3.50±0.56	0.567
	AMP	15.42±2.05	11.27±5.13	12.40±3.75	0.282
	CV	55,04±2.07	53.71±4.73	54.59±4.22	0.832
	F-Min	27.05±3.47	26.62±1.88	28.05±2.99	0.507
Motor Ulnar	DML	2.55±0.34	2.55±0.33	2.22±0.34	0.118
	AMP	11.87±1.62	12.81±1.83	10.63±2.53	0.104
	CV	52.47±2.22	56.43±3.22	59.48±4.12**	0.011*
	F-Min	28.55±3.23	27.50±1.40	27.45±2.15	0.644
Motor Tibial	DML	3.36±0.71	3.96±0.96	3.59±0.98	0.496
	AMP	11.47±6.18	15.40±4.99	16.86±5.65	0.287
	CV	45.31±2.59	44.40±2.01	46.48±4.24	0.363
	F-Min	50.85±7.02	50.22±2.57	46.37±4.53	0.118
Motor Peroneal	DML	4.37±0.78	4.07±0.71	3.97±0.52	0.617
	AMP	6.15±2.38	6.97±2.08	6.96±2.83	0.829
	CV	49.10±6.61	48.25±3.99	52.46±5.75	0.222
	F-Min	49.55±7.62	45.38±3.92	43.22±9.23	0.336
Sensory Median	AMP	30.62±12.39	28.36±10.80	31.57±15.28	0.858
	CV	54.27±5.57	53.44±6.16	58.66±5.21	0.162
Sensory Ulnar	AMP	23.05±15.96	21.57±6.36	29.60±15.96	0.368
	CV	56.31±9.08	58.26±7.21	56.28±5.18	0.794
Sensory Sural	AMP	15.55±10.54	16.90±9.35	11.68±5.67	0.425
	CV	49.68±8.50	51.07±5.42	52.30±4.39	0.747

Nerve conduction was also performed in left side limbs, and data was similar to that of right side. Data presented are mean±SD. Analysis of data was done by one-way ANOVA and post-hoc by Tuky-Krammer test. The ** depicts comparison of BMI < 18 with BMI 23-27.9. *P<0.05; **P<0.05.

MNCS: motor nerve conduction studies; SNCS: sensory nerve conduction studies; DML: distal motor latency in millisecond; AMP: amplitude in mV (motor nerve); in µV (sensory nerve); CV: conduction velocity in m/s; F-Min: F-min latency in millisecond; BMI: Body Mass Index.

DISCUSSION

Normal values are needed for clinical evaluation of individual patient and as control data for epidemiological studies. This study examined the influence of body mass index (BMI) on nerve conduction parameters of commonly studied upper and lower limb nerves. Results were statistically analyzed to provide reference values for the healthy adult population of Central India. Our observation are in agreement with Awang MS et al (1) who observed slowing of conduction velocity (CV) with increasing BMI in median nerve (motor and sensory) and peroneal nerves. They also have noticed no observable trend in sensory ulnar nerve CV. However, in contrast to their findings, we reported no observable fixed trend in CV of motor Ulnar and Sural nerves. In older age group CV was found to be increasing with higher BMI in motor Ulnar nerve. This observation, though statistically significant, is of little clinical significance and in absence of a trend among the other nerves is of doubtful importance. Our findings are in contrast with Baqai HZ et al (9) who reported no effect of BMI on nerve conduction studies. Buschbacher RM et al (10) found longer latency association with lower BMI in motor ulnar and peroneal nerves. This coincides with our findings. This observation might be due to the fact that more superficial peroneal nerve is more dependent on subcutaneus fat thermal insulation to maintain higher perineural temperature and thus thinner individual may have a lower temperature around this nerve than would a heavier person. This could account for longer latency in thinner people (10). They also reported significant association between latency and BMI in sensory Radial and Ulnar nerves. In all other sensory nerves and in median, tibial (motor) nerves no statistically significant difference was observed in latency, amplitude and CV with varying BMI. In all sensory nerves, amplitude was found to be varying with BMI (higher BMI associated with lower amplitude). Our observation was similar to them. In present study, we found influence of BMI greater on sensory nerve conduction study as compared to motor study. Sensory studies exhibited same trend of greater amplitude with lower BMI. Similar were the findings reported by Hasanzadeh P et al (3). This observation might be due to amplitude attenuation by thicker subcutaneous tissue in the person with higher BMI (10). Sensory amplitude are decreased but motor amplitudes are spared with changing BMI, this is probably due to the thousand fold difference in sensory and motor amplitude (10). The fastest fibers conduct equally quickly in thin and heavy individuals; this could be the explanation why did not we notice observable fixed trends in regard with distal motor latency (DML) and F-wave minimum latency with varying BMI. In conclusion, this study demonstrates that various parameters of nerve conduction study can be affected by BMI. So, this biological factor must be taken into consideration while interpreting nerve conduction studies.

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EFFECT OF AGE, GENDER AND BODY MASS INDEX ON VISUAL AND AUDITORY REACTION TIMES IN INDIAN POPULATION

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Abstract : The effect of Age. Gender and Body Mass Index (BMI) on the *Visual* (VRT) and Auditory reaction time (ART) was studied in 30 males and 30 females in the age group of 18-20 years along with 30 males and 30 females in the age group of 65-75 years. Statistical analysis of the data by one-way ANOVA and post-hoc by Tukey-HSD test showed that BMI, VRT and ART were significantly higher in old than young individuals. Females had higher BMI and longer reaction times than males. There was significant positive correlation between BMI and reaction times (VRT and ART) in both males and females by Pearson correlation analysis. Older individuals should be more careful and vigilant about the injuries and falls due to increased reaction time. Longer reaction times and higher BMI in females could be attributed to fluid and salt retention due to female sex hormones affecting sensorimotor co-ordination.

Key words : gender body mass index visual reaction time auditory reaction time sensorimotor co-ordination

INTRODUCTION

Reaction time is defined as an interval of time between the application of stimulus and the initiation of appropriate voluntary response under the condition that the subject has been instructed to respond as rapidly as possible (1). Thus it indicates the time taken by an individual to react to external stimulus (2). In everyday life one has to respond almost instantaneously to many diverse situations. Many simple situations of reaction time are usually at our home itself e.g. response to a door bell, telephone ring or whistle of pressure cooker.

One measure of information processing is reaction time and is used to judge the ability of the person to concentrate and coordinate. It provides an indirect index of the integrity and processing ability of the central nervous system (3) and a simple, non invasive means of determining sensorimotor co-ordination and performance of an individual (4).

With improving health care and services, the entire world has seen a spurt of growth

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in geriatric population. Some factors like nutrition, exercise, personal habits, environmental influences, substances like antioxidants in heroic doses can slow down the process of aging to some degree, still it has proved to be almost an inevitable process.

The process of aging is characterised by progressive and generalised impairment of homeostasis resulting in declining ability to respond to external or internal stresses and increased risk of diseases (5). It is associated with many changes including a general decline in sensorimotor function, which may impair the ability to perform activities of daily living safely and independently (6). A critical element in safe performance of activities of daily living is the ability to react to incoming stimuli and its slowing has obvious consequences for life, such as applying the brakes of a car to avoid collision.

One persistent finding in literature is a slowing of responses with advancing age (6, 7, 8). As the proportion of older individuals continue to rise, it is increasingly important that they are able to remain mobile and independent. One of the largest implications that an increased reaction time may have is in the area of slips and falls. Falls are commonly incurred by one third of the elderly population and are a common source of morbidity and mortality in them (9).

Further, studies indicate that the females have a faster processing ability and hence have a shorter reaction time as compared to their male counterparts (10). Shandan et al (11) have reported that girls above eight years age have mental alertness superior to the boys of comparable age and have intellectual abilities which are at least one to two years ahead of the boys. These observations have been contradicted by other workers (2, 12).

The effect of Body Mass Index (BMI) on reaction time has not been studied extensively to establish any correlation between the two, but the factor of BMI is likely to influence reaction time. BMI is an index of weight adjusted for stature which is body weight (in kilograms) divided by the square of the height (in meters). It is a convenient, easy to measure and useful tool for diagnosing obesity or malnutrition and related health risks. The acceptable range of BMI is from 18.5 to 25. BMI values above 25 are considered abnormal. Individuals with BMI values 25-30 are overweight, and those with values more than 30 are obese (13). Though, there is a strong correlation between BMI and total fat mass there can be misclassification. For example, athletes having larger skeletal muscles and shorter individuals usually have high BMI, but they are not obese. Hence diagnosis should take into account certain factors like person's age, gender, fitness, and ethnicity.

Considering reaction time as a good indicator of sensorimotor co-ordination and performance of an individual and keeping in view the conflicting reports about the reaction time in male and female subjects, with a lacunae present in literature in respect of determination of reaction time with reference to BMI of an individual, present study is undertaken to study the effect of Age, Gender and Body Mass Index on Visual and Auditory reaction time.

MATERIALS AND METHODS

The study was carried out in the premises of Seth G. S. Medical College and K.E.M. Hospital, Mumbai with prior approval from the Dean, H.O.D of Physiology and Medicine department and Ethics committee for research on human subjects of the Institute.

Subjects were divided into four study groups of young males, young females, old males and old females, as per their age and sex respectively. For study group comprising of young individuals, healthy 30 male and 30 female first year medical undergraduate students in the age group of 18-20 years and for study group comprising of old individuals, healthy 30 male and 30 female in the age group of 65-75 years from the geriatric OPD seen by the Medicine Department of the Hospital, fulfilling the inclusion criteria were selected randomly.

Chronically ill subjects with history of any major illnesses like diabetes, hypertension, neuromuscular disorders, psychiatric disorders, addictions to alcohol and tobacco or any medications for long duration in present or past were excluded. The purpose, procedure and non invasive nature of the study were explained and written informed consent for the study was taken from each subject. Tests for hearing, vision and motor system examination and reflexes in upper limb were carried out to rule out any visual, auditory and neuromuscular disorders respectively. Age (years), sex and anthropometric parameters; height (meters) and weight (kg) were noted for each subject. Height of the subject was measured using a measuring scale whose least count is 0.1 cm. Height of each subject was converted in unit of metres. Weight was measured using weighing machine whose least count was 0.5 kg. BMI of each subject was calculated using Quetelet's index: BMI = Weight (kg)/Height^2 (m).

None of the subjects had seen or worked on the apparatus of reaction time before the test. The apparatus used to measure reaction time was Research Reaction timer with two response choices by Anand Agencies, Pune-2. It is a portable device with inbuilt four-digit chronoscope with least count of 1/1000 sec. i.e. 1 millisecond. Green light stimuli and click sound stimuli were selected for recording VRT and ART respectively. Before measuring VRT and ART, each subject was made familiar with the apparatus. All the readings were taken between 9-10 am in the morning in a quite room. While performing the test, all the subjects were made to sit comfortably in a chair and were motivated to better their results as much as possible. As soon as the stimulus was perceived by the subjects, they were asked to respond by pressing the response switch by index finger of dominant hand. Three readings of each stimuli; green light and click sound were noted from auto display in msecs. for each subject after giving three practice trails. Lowest reading was taken as the value for the reaction time task; VRT and ART respectively, which was considered for statistical analysis.

Statistical analysis of data

In the present study, all data collected were analyzed using SPSS Version 17. Mean was calculated for different parameters in each study group. Mean is a measure of central tendency and is the one value around which other values are dispersed. Standard

deviation (S.D) which denotes the measure of variability or dispersion from the mean value was calculated. The recorded values were expressed as Mean±SD. Statistical analysis of the data was done using one-way Analysis of Variance (ANOVA) and Post-hoc by Tukey-Honestly significant difference (HSD) test as each study group had equal sample size (n=30). ANOVA is a group of statistical techniques used to compare the means of two or more samples to see whether they come from same population. This technique expands on the tests for two means, such as the t-test. Statistical significance of difference was determined. The P value gives the probability of any observed difference having happened by chance. P value of 0.05 means that the probability of the difference having happened by chance is 0.05 in 1 i.e. 1 in 20. P value below 0.05 was considered to be statistically significant and P value below 0.01 was considered to be highly significant.

RESULTS

Table I depicts Mean and standard deviation values of different parameters: Age, Body Mass Index (BMI), Visual reaction time (VRT) and Auditory reaction time (ART) for each study group with inter-group comparison of significance. As shown in Table I, BMI were significantly higher in older individuals than young individuals for both sexes (P<0.001). BMI were more in females than males in both age groups, but the difference was not statistically significant. VRT were significantly higher in older individuals than young individuals in either sex (P=0.000). ART were also significantly higher in old individuals than young individuals in either sex (P = 0.000). Reaction times for each stimulus visual and auditory (VRT and ART) were higher in females than males in both age groups, but difference between two were not statistically significant.

Table II shows that on correlation of BMI with reaction times (VRT and ART) in males

TABLE II: Correlation of BMI with reaction times (VRT and ART) in males and females of both age groups.

Parameters	*Males (n=60)*		*Females (n=60)*	
	r-value	*P-value*	*r-value*	*P-value*
VRT	0.514**	0.000	0.506**	0.000
ART	0.472**	0.000	0.543**	0.000

**P<0.01-statistically highly significant.

TABLE I: Comparison of Age, BMI, Visual (VRT) and Auditory reaction time (ART) in different study group subjects.

Parameters	*Young males (n=30)*	*Young females (n=30)*	*Old males (n=30)*	*Old females (n=30)*
Age (years)	18.46±0.57	18.57±0.50	70.03±3.52	71.87±3.48
BMI (kg/m^2)	19.82±3.54$^{□□,ΔΔ}$	21.72±3.32$^{□□,ΔΔ}$	25.39±5.00**$^{,\#\#}$	26.82±4.24**
VRT (msecs)	220.4±28.27$^{□□,ΔΔ}$	235.6±33.51$^{□□,ΔΔ}$	340.5±36.44**$^{,\#\#}$	359.1±38.75**$^{,\#\#}$
ART (msecs)	189.6±20.45$^{□□,ΔΔ}$	197.7±34.46$^{□□,ΔΔ}$	332.3±42.16**$^{,\#\#}$	341.3±41.69**$^{,\#\#}$

Data presented are mean±SD. Analysis of data was done by one-way ANOVA and post-hoc by Tukey-HSD test. The * depicts comparison with young males, # depicts comparison with young females, □ depicts comparison with old males and A depicts comparison with old females. **, ##, □□, ΔΔ depicts P<0.01-statistically highly significant.

and females of both age groups by Pearson correlation analysis, there was a statistically significant positive correlation between BMI and reaction times (P=0.000).

DISCUSSION

In the present study, both VRT and ART were significantly higher in old than the young individuals for both the sexes. Though the analysis of literature shows a common observation but the course, location and the nature of slowdown is not very clear. All the components of reaction time; the mental processing time to perceive a signal and to decide upon a response, movement time and device response time are likely to get delayed in elderly. Senile changes in peripheral processes, like decelerated muscular response and impulse transduction through sensory nerves can account for 20% of reaction time lengthening (14). But since sensory receipt and motor outflow times are believed to remain similar across the lifespan, the cause could be the slowed processing rate of Central Nervous System in old individuals (15).

Older people also have a tendency to be more careful and monitor their responses more thoroughly. When troubled by a distraction they tend to devote their exclusive attention to one stimulus, and ignore another stimulus completely than young people, further slowing their reaction time (16). Though the effect of age increases with task complexity, cognitive slowing is argued to be a common phenomenon in the elderly (17).

Thus, we can conclude that reaction time task is a good indicator of sensorimotor performance of an individual, as the young individuals performed better in the reaction time tasks than old in the present study. Old people who tend to fall in the nursing homes have shown a significant slower reaction time than those who do not tend to fall (18). This indicates that the old individuals should be more careful and vigilant about the injuries and fall that may occur as a result of increased reaction time.

In the present study, VRT and ART in females were longer as compared to males for both age groups, but not statistically significant. This finding is consistent with the observation of other workers (2, 12) but in contrary to the observation by Shenvi et al (10).

BMI were significantly more in old than young individuals. This can be explained on the basis of observations that as we age, a decrease in our physical abilities leads to a decrease in our metabolic rate, which in turn contributes to weight gain and increased BMI. BMI were also found to be more in females than males, but not statistically significant. The difference in BMI between male and female could be due to obesity but can also be due to other causes such as fluid retention (13). Most likely it is due to the fluctuations in the reproductive hormone concentrations throughout the women's lives, that uniquely predispose them to excess weight gain than males (19).

There was a significant positive correlation found between BMI and reaction times (VRT and ART) in males and females of both age groups. This finding is consistent with the observation of Skurvydas that subjects with greater body mass index react

significantly slower than others (20). In the present study on correlation, it is evident that female subjects who have a higher BMI also have higher reaction times (VRT and ART) as compared to males, but not significant. Bruce and Russel (21) have indicated that varying level of sex steroids during different phases of menstrual cycle have sodium and water retaining effect associated with weight gain in females. This retention of salt and water could modify the axonal conduction and alter the rate of impulse transmission. Further, it is also suggested to alter the availability of the neuro-transmitter at the synaptic level. Thus, we can conclude that the increased synaptic delay coupled with the reduced velocity of nerve impulse due to the effect of female sex hormones affects the sensorimotor co-ordination and the processing speed of the Central Nervous System.

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SHORT COMMUNICATION

COMPARATIVE STUDY OF LUNG FUNCTIONS IN SWIMMERS AND RUNNERS

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Abstract : In the present study pulmonary function tests of two different groups of athletes, swimmers and runners were studied and compared. Thirty swimmers who used to swim a distance of two to three kilometers per day regularly were compared with age, sex, height, and weight matched thirty middle distance runners. Runners and swimmers selected for this study were undergoing training since last three years. Tidal Volume (TV), forced Vital Capacity (FVC). Forced expiratory volume in one second (FEV_1) and maximum voluntary ventilation (MVV) were higher in swimmers than runners. Swimming exercise affects lung volume measurements as respiratory muscles including diaphragm of swimmers are required to develop greater pressure as a consequence of immersion in water during respiratory cycle, thus may lead to functional improvement in these muscles and also alterations in elasticity of lung and chest wall or of ventilatory muscles, leading to an improvement in forced vital capacity and other lung functions of swimmers than runners.

Key words : athletes runners swimmers

INTRODUCTION

Beneficial effect is seen on various systems of the body due to any type of exercise if performed regularly. These systems are benefited by such exercises by way of improving their functions. Swimming and running are considered to be the best exercises for maintaining physical fitness and proper health. These above mentioned exercises have a profound effect on the lung function of an individual. The purpose of selecting swimmers and runners was swimming produces maximum effect on the lungs as compared to running.

The respiratory response to swimming exercise may be expected to be different from the response to running exercise for the following reasons –

1. Act of swimming is performed in horizontal position.
2. Ventilation is restricted in/under

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water and external pressure is increased.

3. Heat conductance of water is higher than that of air.

4. Diaphragm is exposed to greater pressure during swimming than running.

Above mentioned factors in the act of swimming are anticipated to produce gas exchange and circulatory responses that differ from those observed in running.

The aim of this study is to establish a relationship between the quality of exercise performed and quantitative effect of these exercises on the body.

METHODS

Present study was conducted on 30 swimmers and 30 runners in the age group of 20-30 years. The runners were undergoing training under Sports Authority of India, Western Region, Aurangabad and Krida Prabodhini for middle distance running event and swimmers were selected from various swimming clubs from Aurangabad city. All the subjects were clinically examined to rule out any respiratory disorder. Informed consent was obtained from all subjects.

The study was conducted in the department of Physiology, Government Medical College, Aurangabad in Pulmonary Function Test Laboratory by "Body plethysmograph" (ELITE-Dx Model Medgraphics, USA) Pulmonary Function Test (PFT) machine. Subject were made familiar with test procedure and techniques. Tidal Volume (TV), Forced Vital Capacity (FVC), Forced Expiratory Volume 1st second (FEV_1) & maximum voluntary ventilation (MVV) were recorded with subject in sitting position of PFT machine.

Standard statistical analysis test was applied in terms of mean and standard deviation, unpaired 't' test was applied for comparison between two groups.

RESULTS

The results of this study are summarized in Table I. The tidal volume (TV), forced vital capacity (FVC), forced expiratory volume at 1st second (FEV_1) and maximum voluntary ventilation (MVV) of swimmers and runner are given.

It is evident that the swimmers have highest value of lung volumes compared to runners.

During swimming the external pressure is high therefore the respiratory muscles along with diaphragm develop greater pressure for respiration. This leads to improvement in the functional capacity of these muscles (1).

TABLE I: Comparison of pulmonary function test of swimmers and runners.

Parameter	*Swimmers*	*Runners*	*'P' value*	*Statistical significance*
T.V.	1.73±0.29	0.94±0.285	<0.0001	HS
FVC	96.13±8.94	79.63±9.5	<0.001	HS
FEV_1	98.12±8.13	85.23±12.7	<0.001	HS
MVV	122.13±21.96	120.37±29.06	<0.0001	HS

HS = Highly Significant.
NS – Not Significant.

Our study clearly shows that among runners and swimmers, swimmers have higher value of vital capacities and forced expiratory volume in 1st second (1). It was presumed that athletic training has no ventilatory stress in the form of external pressure acting on the lungs as in swimming. The ability of individual to inflate and deflate the lungs depends upon the strength of thoracic and abdominal muscles, posture of individual and elasticity of lungs. Swimming increases this ability by number of factors. It involves keeping the head extended which is constant exercise of erector spinae muscle which increases antero-posterior diameter of the lungs. The sterenocleidomastoid, trapzius and diaphragm are being constantly exercised.

DISCUSSION

Table I shows the mean and S.D. values of tidal volume (TV), Forced Vital Capacity (FVC), Forced expiratory volume at one second (FEV_1) Forced expiratory volume at one second (FEV_1) and maximum voluntary ventilation (MVV) of swimmers and runners. In the swimmers TV (1.73±0.29), FVC (96.13±8.94), FEV_1 (98.12±8.13), MVV (122.13±21.96) were higher than runners. In the runners the values are TV (0.94±0.28), FVC (79.63±9.5), FEV_1 (85.23±12.7), MVV (120.37±29.86).

The results discussed above indicate that swimmers have higher values of lung functions compared with runners. Thereby confirming that physical training has a facilitative effect on ventilatory function and athletes have superior lung function values compared to non-athletes (3, 8, 9, 10, 11).

Regular swimming practice may tend to alter the elasticity of the lungs and chest wall which leads to improvement in the lung function of swimmer (9).

Act of swimming differs from running in the following aspects :

1. Swimming is performed in horizontal position compared to vertical position in running.

2. The breath is held in every respiratory cycle for one moment or other producing a condition of intermittent hypoxia. This intermittent hypoxia sets up the anaerobic process during swimming. The lactic acid levels in the blood go on rising resulting in “lactic oxygen deficit” (12).

During swimming the external, pressure is high therefore the respiratory muscles along with diaphragm develop greater pressure for respiration which leads to improvement in the functional capacity of these muscles (3).

Swimmers have higher value of vital capacity and for expiratory volume in 1st second than runners. It was presumed that athletic training has no ventilatory stress in the form of external pressure acting on the lungs as in swimming (1).

The restricted ventilation experienced during swimming leads the swimmers to face intermittment hypoxia. This may result in alveolar hyperplasia and thus increased tidal volume, forced vital capacity and forced expiratory volume in 1st second than runners (14). Maximum voluntary ventilation (MVV) which depend both on the patency of

airways and strength of respiratory musculature was high in runners and swimmers. This finding supports the view expressed by Leith et al (6, 1).

Endurance training increases the lung capacity, sustained ventilation and thus MVV. The higher values of MVV, in all groups of athletes in comparison to predicted normal values for Indians (11, 8) is in accordance to findings of Shapiro et al (19) who observed that athletes have larger mean vital capacity and MVV.

So the respiratory muscles and diaphragm of swimmers are required to develop greater pressure as a consequence of immersion in water during the respiratory cycle, thus leading to functionally better lung functions in swimmers compared to runners (1).

Vital capacity for swimmers, foot ball players and wrestlers and forced expiratory volume in 1st second for all the groups studied were the predicted normal in Indian soldiers by Verma et al (10) and civil population by Jain and Ramiah (13) MVV seems to be significantly higher in comparison to its predicted normal value in Indians of similar age and height (10, 13).

Astrand et al found that girl swimmers had higher values for vital capacity and total lung capacity (TLC) in relation to height than a non-atheletic reference group (14). Also the mean values for VC & FEV1 were found higher in swimmers of both sexes by Newmann et al (9). Andrew et al suggested that three years of competitive swim training produce greater lungs capacities than that might otherwise be anticipated (15).

Cordain reported that the static lung volumes were higher than normal in swimmers than runners. This was attributed to strengthening of the inspiratory muscles as they were against additional resistance caused by weight of water that compresses the thoracic cage (18).

To explain the difference in the lung volumes and capacities in swimmers and runners more extensive and detailed research with each group is required.

This study suggest that regular exercise training has an important role to play in determining and improving lung volumes, and also that swimming exercise builds up more endurance of respiratory muscles than running exercise. There is a need of further to test the hypothens.

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