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Highlights

Gestation Diabetic Detection

Lymphatic Drainage on Triglycerides

Discovering Thoughts, Inventing Future

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Contents of the Issue

i. Copyright Notice
ii. Editorial Board Members
iii. Chief Author and Dean
iv. Contents of the Issue

1. A Gestation Diabetic Detection Technique using Muscle Energy Derived from Surface EMG. *1-11*
2. Effect of Aerobic Training on Ventricular Remodeling After Percutaneous Coronary Intervention *13-18*
3. The Impact of Low Frequency Ultrasound and Lymphatic Drainage on Triglycerides. *19-28*
4. MRI-T1 and T2 Image Fusion for Brain Image using CDF Wavelet based on Lifting Scheme. *29-33*

v. Fellows
vi. Auxiliary Memberships
vii. Process of Submission of Research Paper
viii. Preferred Author Guidelines
ix. Index

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A Gestation Diabetic Detection Technique using Muscle Energy Derived from Surface EMG

By Anjaneya L. H, Mallikarjun S. Holi & Dr. S. Chandrasekhar

Abstract- Electromyogram (EMG) is one among the important biopotential signal reflecting the human skeletal muscle activity. EMG signals can be used for many biomedical applications pertaining to diagnosis and therapy of musculoskeletal and rheumatological problems. EMG signals are complex in nature and require advanced techniques for analysis, such as decomposition, detection, processing, and classification. Diabetes mellitus is a chronic metabolic disorder characterized by elevated levels of blood glucose. The musculoskeletal system can be affected by diabetes in a number of ways. The main aim of the paper is to identify the diabetic patient and show the classification performance of the proposed framework. In this paper EMG signal is investigated by feature extraction and are classified into normal and diabetic for comprehension of EMG signal. The primary point of this work is to recognize the diabetes utilizing different elements and to demonstrate the performance of the proposed framework. The obtained results demonstrate that the extracted feature in proposed framework displays better performance for classification the EMG signal contrasted with alternate elements. Based on the impacts of features on the EMG signal classification, different results were obtained through analysis of the SVM Classification. Experimental study shows that the proposed method's classification accuracy is 98.98%.

Keywords: feature extraction; electromyography (EMG) signal; SVM classifier.

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AGESTATIONDIABETICDETECTIONTECHNIQUEUSINGMUSCLEENERGYDERIVEDFROMSURFACEEMG

Strictly as per the compliance and regulations of:

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Anjaneya L. H [α], Mallikarjun S. Holi [σ] & Dr. S. Chandrasekhar [ρ]

Abstract- Electromyogram (EMG) is one among the important biopotential signal reflecting the human skeletal muscle activity. EMG signals can be used for many biomedical applications pertaining to diagnosis and therapy of musculoskeletal and rheumatological problems. EMG signals are complex in nature and require advanced techniques for analysis, such as decomposition, detection, processing, and classification. Diabetes mellitus is a chronic metabolic disorder characterized by elevated levels of blood glucose. The musculoskeletal system can be affected by diabetes in a number of ways. The main aim of the paper is to identify the diabetic patient and show the classification performance of the proposed framework. In this paper EMG signal is investigated by feature extraction and are classified into normal and diabetic for comprehension of EMG signal. The primary point of this work is to recognize the diabetes utilizing different elements and to demonstrate the performance of the proposed framework. The obtained results demonstrate that the extracted feature in proposed framework displays better performance for classification the EMG signal contrasted with alternate elements. Based on the impacts of features on the EMG signal classification, different results were obtained through analysis of the SVM Classification. Experimental study shows that the proposed method's classification accuracy is 98.98%.

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I. Introduction

For the evaluation and administration of patient health, observing of physiological and physical signal is crucial. Electromyogram is a critical health pointer. EMG is likewise utilized as a part of numerous sorts of exploration labs, incorporating those included in engine control, neuromuscular physiology, biomechanics, development issue, postural control, and exercise based recuperation. Physiological and anatomical properties of muscles are presented by the signals; an EMG sign is the electrical action of a muscle's engine units, which comprise of two sorts: surface EMG, and intramuscular EMG [1]. Surface EMG and intramuscular EMG signs are recorded by non-intrusive cathodes and obtrusive terminals, separately. Nowadays, surface-identified signs are ideally used to acquire data about the time or power of shallow muscle enactment [2].

Electromyography (EMG) signs are viewed as most valuable as electrophysiological signs in both medical and engineering fields. The essential strategy for comprehension the human body's practices under typical and neurotic conditions is given by the recording of EMG signs. At whatever point an EMG sign is being recorded from the muscle, different sorts of clamors defile it. In this way, dissecting and characterizing the EMG signs is exceptionally troublesome on account of the complicated pattern of the EMG, particularly when EMG movement happens. EMG is controlled by sensory system and relies on upon anatomical and mental properties of muscles. It is an electrical sign gained from diverse organs. EMG is typically an element of time, discussed in terms of amplitude, phase and frequency. Electromyography (EMG) signs presents to the electrical movement of a muscle amid compression [1].

These signs may be recognized from skin surface anodes or from needles set specifically inside of the muscle. These two sorts of recordings are utilized for diverse purposes, with needle recording used to recognize the conduct of individual muscle motor and fiber units while surface recordings are utilized to distinguish general muscle action specifically positions or activities. Surface EMG is not a typical clinical technique; however it might be utilized as a part of restoration (rehabilitation). Needle electromyography is utilized to figure out if there is harm to nerve filaments to individual muscles. At the point when nerve sends the sign to start muscle constriction a potential is produced over the muscle because of the stream of particles all through muscle cells (i.e. developments of electrolytes) and this ionic current is changed over into electronic current with Ag-AgCl anodes put on the surface of the skin of the contracting muscle. Recently a surface electromyography is progressively utilized for recording from shallow muscles in clinical conventions, where intramuscular cathodes are utilized for profound muscle only [3].

The innovation of EMG is moderately new. There are still restrictions in characterization and detection of EMG sign, phase estimation, procuring suitable data because of induction from typicality. Conventional framework remaking calculations have different impediments and extensive computational complexity quality and numerous show high differences.

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Global Journal of Medical Research (K) Volume XV Issue VI Version I Year 2015

Recently in innovations of signal handling and numerical models have made it to create progressed EMG location and examination strategies [4]. In this way, look into and broad researches have been made in the zone, growing better algorithms, overhauling existing approaches, enhancing recognition methods to diminish clamor, and to gain exact EMG signals. It is very imperative to do an examination to group the real issues of EMG signs investigation and legitimize the acknowledged measures. Higher-order factual routines may be utilized for analyzing the EMG signal because of the one of a kind properties of measurable techniques connected to arbitrary time arrangement. This paper identifies with the redesigning existing procedures filtering, processing, decomposition and modeling of EMG. In our proposed work our principle expect to recognize and order the diabetic patient for that EMG signal information has been considered to do the work. By utilizing the EMG signal it can be dissected what nerves have been harmed and how broad that harm is. An electromyography (EMG) test is often done in conjunction with a Nerve Conduction Velocity (NCV) test. It shows how well muscles are receiving signals from the nerves. Damaged nerves won't send clear or consistent messages.

Reminder of this paper is organized as follows: Section 2 presents the related work in this area. Section 3 presents proposed method for classifying EMG diabetic signal. Section 4 gives detailed description about the result obtained. And the paper is concluded in Section 5.

II. Related Work

This section provides the previous researches in the field of EMG signal processing i.e. feature extraction, noise removal, filtering and classification.

Nishikawa and Kuribayashi et al. [1], Used neural system to segregate hand movements for EMG-Controlled Prostheses. Here the neural system was utilized to take in the connection between EMG signal's energy spectrum and the movement errand craved by the incapacitated subjects.

Xiao Hu; Qun Yu et al. [2] presented a novel and basic technique to extricate the general element of two surface EMG sign examples: lower arm supination surface EMG flag and lower arm pronation surface EMG signal. The system decays surface EMG signal into 16 Frequency groups (FB) by wavelet bundle change (WPT), and afterward wavelet coefficient entropy (WCE) of two picked FBs is ascertained. The two WCEs were utilized to recognize FS surface EMG signals from lower arm supination surface EMG signals. The outcome demonstrates that WCE is a powerful technique for removing the component from surface EMG signal.

kouchaki, s.; Boostani et al. [3] proposed a compelling combinational feature to upgrade the accuracy of classification among the control group and subjects with neuropathy and myopathy illnesses. All EMG signs were create and simulated artificially, by fusing measurable and morphological properties of every group into their sign models, in the EMG lab of Waterloo University. To characterize the subjects by the proposed system, in the first place, EMG signs are deteriorated by observational mode decay or Empirical mode decomposition(EMD) to its regular subspaces, then number of subspaces is adjusted through every windowed sign, and Kolmogorov Complexity (KC) and other informative component are resolved to uncover the measure of anomaly inside of every subspace. Finally, these elements are connected to support vector machine (SVM).

ZhaojieJu; Gaoxiang Ouyang et al. [4] proposed and assessed systems for nonlinear feature extraction and nonlinear classification to recognize distinctive hand controls taking into account surface electromyography (sEMG) signals. The nonlinear measures are accomplished in light of the repeat plot to represent to dynamical attributes of sEMG amid hand movements. Fuzzy Gaussian Mixture Models $(FGMMs)$ are proposed and utilized as a nonlinear classifier to perceive distinctive hand handles and close by controls caught from diverse subjects. Different trials are led to assess their execution by looking at 14 individual elements, 19 multifeatures and 4 distinct classifiers. The test results exhibit the proposed nonlinear measures give vital supplemental data and they are key to the great execution in multifeatures.

Artug, N.T.; Goker et al. [5] proposed another system for feature extraction. In this study another dataset are prepared for neuromuscular sicknesses utilizing checking EMG strategy and four new components are extricated. These components are described as duration of phase, maximum amplitude the maximum amplitude, and maximum amplitude times phase duration, and number of peaks. By utilizing factual values, for example, mean and variance, number of elements has expanded up to eight. This dataset was characterized by utilizingk-nearest neighbors calculation $(k-NN)$, radial basis function networks (RBF), support vector machines (SVM), andmulti-layer perceptron (MLP).

III. Proposed System

As a result of the different clamors and antiques identified among EMG signs, obliged data remains an amalgam inside the raw EMG signals. Then again, if these raw signals are utilized as a data as a part of sEMG order, the proficiency of the classifier reduces. To enhance the performance of the classifier, researchers have been utilizing distinctive sorts of EMG elements as an information to the classifier. To accomplish ideal order execution, the properties of EMG highlight space should be taken into consideration. There are three sorts of EMG components in diverse spaces: time area, frequency area and time-frequency space features. Hudgins et al. created time area elements of the sEMG. They utilized mean absolute value (MAV), mean absolute value slope, slope sign changes (SSC), waveform lengths (WL) and zero crossing (ZC) for presenting to myoelectric examples. These components are termed as 'the Hudgins highlight'. A deliberately chose set of info components gives a higher grouping rate than the crude sign. In the journey to enhance, the precision of myoelectric sign example grouping Englehart et al. looked at time space (TD) components utilized by Hudgins with the time recurrence area highlights (TFD). Time-recurrence area elements are viable capabilities particularly for transient myoelectric sign example characterization. Because of the high dimensionality and high-determination issue of time-frequency representation, dimensionality lessening is regularly an important supplement to highlight extraction. Every one of them should be possible progressively and electronically and it is straightforward for usage. Feature in this group are regularly utilized for onset identification, muscle constriction and muscle action recognition.

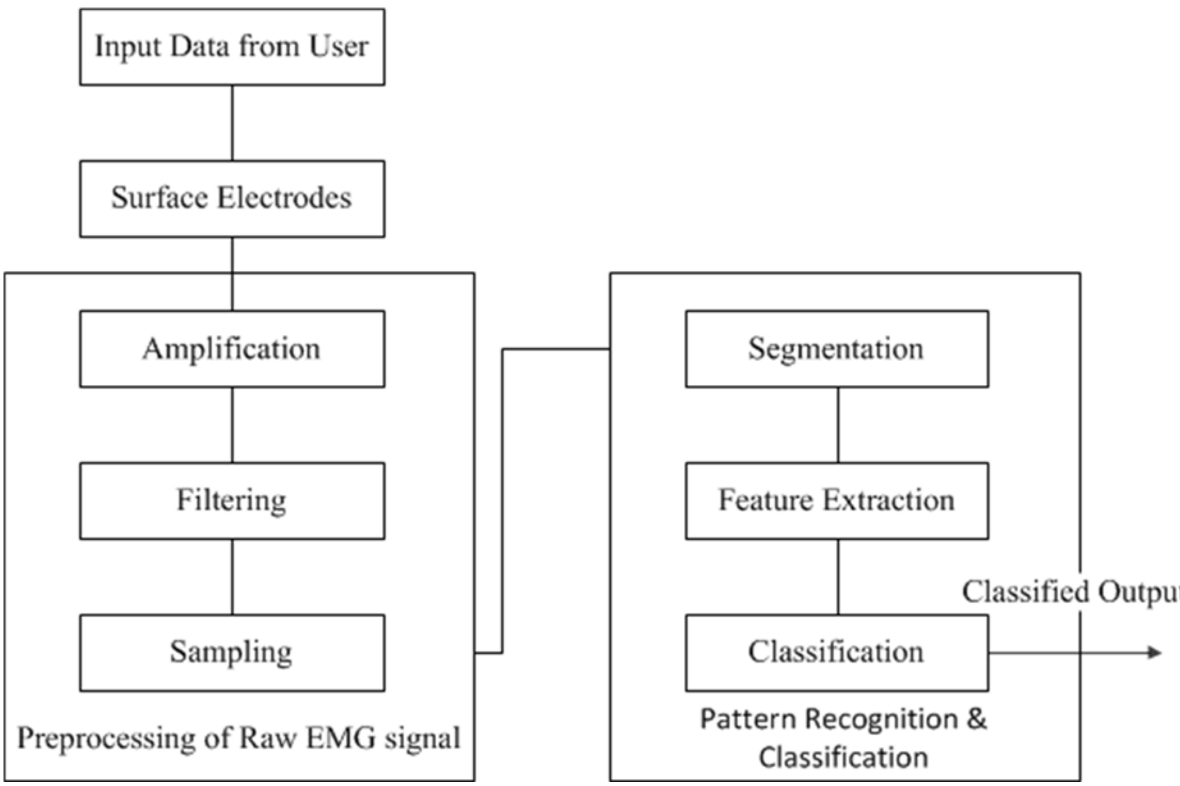

Figure 1 : Overall System Architecture

Above given fig1 presents the overall architecture of the framework. To collect the EMG data surface electrodes are being used, this data is called raw data. To perform the desired operation on this data we need to do some preprocessing on this data i.e. amplification, filtering and sampling. The next step is to perform segmentation on the data. After this step the data is divided into samples which are compatible for feature extraction. In our proposed framework various features are extracted which are described below.

Fifteen time domain features and frequency domain features are described in this section. Thirteen time domain variables are measured as a function of time. Because of their computational simplicity, time domain features or linear techniques are the most popular in EMG pattern recognition. Integrated EMG, Mean absolute value, Modified mean absolute value 1, Modified mean absolute value 2, Mean absolute value slope, Willison amplitude Zero crossing, Root mean square, Slope sign change, Variance of EMG, Waveform length and Histogram of EMG are used to test the performance. Additionally, highlights in recurrence area are utilized to speak to the identify muscle weakness and neural anomalies, and at some point are utilized as a part of EMG example acknowledgment. Three customary and two adjusted elements in recurrence range are performed specifically autoregressive coefficients, mean and middle frequencies, changed mean and middle frequencies. A while later, the assessment techniques for two models that used to quantify the power property of the entire components

Global Journal of Medical Research (K) Volume XV Issue VI Version I Year 2015

are presented. Finally the classification is done on the feature extracted data.

IV. Feature Extraction in Time Domain

a) Integrated EMG

Integrated EMG $(IEMG)$ is computed as the summation of the total estimations of the $sEMG$ signal amplitude. For the most part, $IEMG$ is utilized as an onset list to recognize the muscle movement that used to approaching the control charge of assistive control gadget. It is identified with the $sEMG$ sign arrangement terminating point, which can be communicated as

$$IEMG = \sum_{n=1}^{N} |x_n|, \tag{1}$$

where N denotes the length of the signal and x_n represents the $sEMG$ signal in a segment.

b) Mean Absolute Value

Mean Absolute Value (MAV) is like normal corrected quality. It can be figured utilizing the moving normal of full-wave amended EMG. It is ascertained by taking the normal of the total estimation of $sEMG$ sign. It is a simple route for location of muscle compression levels and it is a prominent element utilized as a part of myoelectric control application. It is characterized as

$$MAV = \frac{1}{N}\sum_{N=1}^{N} |x_n| \tag{2}$$

c) Modified Mean Absolute Value 1

It is an addition in MAV using weighting window functionw_n. It can be defined as

$$MAV1 = \frac{1}{N}\sum_{n=1}^{N} w_n|x_n| \tag{3}$$

$$w_n = f(x) = \begin{cases} 1, if\ 0.25N \le n \le 0.75N \\ 0.5 \qquad\qquad\qquad , otherwise \end{cases}$$

d) Modified Mean Absolute Value 2

Modified Mean Absolute Value 2 $(MMAV2)$ is similar to $MMAV1$. In this method by using continuous weighting window functionw_n , the smooth window is improved. It is given by

$$MMAV2 = \frac{1}{N}\sum_{n=1}^{N} w_n|x_n| \tag{4}$$

$$w_n = \begin{cases} 1, if\ 0.25N \le n \le 0.75N \\ \dfrac{4n}{N}, if\ 0.25N > n \\ \dfrac{4(n-N)}{N}, if\ 0.75 < n. \end{cases}$$

e) Mean Absolute Value Slope

Mean Absolute Value Slope $(MAVSLP)$ is a modified version of MAV. The differences between the $MAVs$ of adjacent segments are determined. It can be defined as

$$MAVSLP_i = MAV_{i+1} - MAV_i \tag{5}$$

f) Variance of EMG

Variance of EMG (VAR) uses the power of the $sEMG$ signal as a feature. Generally, the variance is the mean value of the square of the deviation of that variable. However, mean of EMG signal is close to zero. In consequence, variance of EMG can be calculated by

$$VAR = \frac{1}{N-1}\sum_{n=1}^{N} x_n^2 \tag{6}$$

g) Root Mean Square

Root Mean Square (RMS) is modeled as amplitude modulated Gaussian random process whose RMS is related to the constant force and non-fatiguing contraction. It relates to standard deviation, which can be expressed as

$$RMS = \sqrt{\frac{1}{N}\sum_{n=1}^{N} x_n^2} \tag{7}$$

h) Waveform Length

It is a measurement of cumulative length of the waveform over time segment. $WL$is related to the waveform amplitude, frequency and time. It is given by

$$WL = \sum_{n=1}^{N-1} |x_{n+1} - x_n| \tag{8}$$

All of these features above, eq.1-eq.8 are computed based on sEMG signal amplitude. From the experimental results, the pattern of these features is similar. Hence, we selected the robust feature representing for the other features in this group. The results and discussion is presented in Section 4.

i) Zero Crossing

Zero intersection (ZC) is the quantity of times that the adequacy estimation of sEMG sign crosses the zero y-axis. In EMG highlight, the edge condition is utilized to go without the background clamor. This component gives a surmised estimation of recurrence space properties. It can be detailed as

$$ZC = \sum_{n=1}^{N-1} [\, sgn(x_n \times x_{n+1}) \cap |x_n - x_{n+1}| \, \geq threshold] \tag{10}$$

$$sgn(x) \begin{cases} 1, & if\ x \geq threshold \\ 0, & otherwise \end{cases}$$

j) Slope Sign Change

Slope Sign Change (SSC) is like ZC. It is another technique to present to the recurrence data of sEMG sign. The quantity of changes in the middle of positive and negative slant among three continuous portions is performed with the edge capacity for keeping away from the impedance in sEMG signal. The count is characterized as

$$SSC = \sum_{n=2}^{N-1} [f[(x_n - x_{n-1}) \times (x_n - x_{n+1})]]; \tag{11}$$

$$f(x) = f(x) = \begin{cases} -1, & if\ x \geq threshold \\ 0 & ,\ \ otherwise \end{cases}$$

k) Willison Amplitude

Willison amplitude (WAMP) is the quantity of times that the contrast between sEMG signal adequacy among two contiguous portions that surpasses a predefined limit to lessen commotion impacts same as ZC and SSC. The definition is as

$$WAMP = \sum_{n=1}^{N-1} f(|x_n - x_{n+1}|); \tag{12}$$

$$f(x) = \begin{cases} 1, & if\ x \geq threshold \\ x & ,\ \ otherwise \end{cases}$$

WAMP is related to the firing of motor unit action potentials (MUAP) and the muscle contraction level. The suitable value of threshold parameter of features in ZC, SSC, and WAMP is normally chosen between 10and 100 mV that is dependent on the setting of gain value of instrument. Nevertheless, the optimal threshold that suitable for robustness in sEMG signal analysis is evaluated and discussed in Section 4.

V. Frequency Domain Feature Extraction

a) Autoregressive Coefficients

Autoregressive (AR) model described each sample of sEMG signal as a linear combination of previous samples plus a white noise error term. AR coefficients are used as features in EMG pattern recognition. The model is basically of the following form:

$$x_n = -\sum_{i=1}^{p} a_i x_{n-i} + w_n, \tag{13}$$

where x_n is a sample of the model signal,w_n is AR coefficients,w_n is white noise or error sequence, and p is the order of AR model. The forth order AR was suggested from the previous research [19]. However, the orders of AR between the first order and the tenth order are found. The results are discussed in Section 4.

b) Modified Median Frequency

Modified Median Frequency (MMDF) is the frequency at which the spectrum is divided into two regions with equal amplitude. It can be expressed as

$$\sum_{j=1}^{MMDF} A_j = \sum_{j=MMDF}^{M} A_j = \frac{1}{2}\sum_{j=1}^{M} A_j, \tag{14}$$

where A_j is the sEMG amplitude spectrum at frequencybin j.

c) Modified Mean Frequency

Modified Mean Frequency (MMNF) is the average frequency. MMNF is calculated as the sum of the product of the amplitude spectrum and the frequency, divided by the total sum of spectrum intensity, as in

$$MMNF = \sum_{j=1}^{M} \frac{f_j A_j}{\sum_{j=1}^{M} A_j}, \tag{15}$$

where f_j is the frequency of spectrum at frequency bin j.

According to the proposed method for EMG classification the above given mathematical equation are used for the frequency and time domain feature extraction.

Because of the way of the EMG signal, there would be an extensive variety in the estimation of specific features between individuals. Numerous elements, for example, changes in terminal position, sign preparing will deliver changes in highlight values after some time. A suitable acknowledgment technique must have the capacity to oblige the normal individual contrast. SVM Classifier hypothesis assumes an imperative critical part in managing vulnerability when settling on choices in biomedical field of uses. The classifier proposed for the grouping of the EMG signs was executed by a basic methodology in view of Support Vector Machine is to arrange the EMG sign to one of the classifications, Diabetic or Non-Diabetic.

VI. Results and Discussion

a) Data Recording Stage

The EMG records correspond to the activity of the uterine muscles and might therefore be used to predict the premature onset of labor. Records were collected from the general population as well as from the patients admitted to the hospital with the diagnosis of impending pre-term labor. One record pre-pregnancy was recorded. The records are of 30-minduration and consist of three channels. The sampling frequency, fs, was 20 Hz. The records were collected from the abdominal surface using four AgCl2 electrodes. The electrodes were placed in two horizontal rows, symmetrically under and above the navel, spaced7 cm apart. A special protocol was used during the attachment of the electrodes in order to improve the quality of the measurements [13]. According to the protocol, the resistance between the electrodes had to be lower than $100\ k\Omega$. The first acquired signal was measuredbetween the topmost electrodes (E2–E1), the second signal between the leftmost electrodes (E2–E3) and the third signal between the lower electrodes (E4–E3). Prior to sampling the signals were filtered using an analog three pole Butterworth filter with the bandwidth from 0 to 5 Hz. The resolution of the scanning system was 16 bits with the amplitude range ±2.5 mV.

In our experiment we have considered 297 users EMG signal data. Out of 297, 295users are not having diabetes and the remaining 2 users are diabetic affected.

The given table 1 shows the mean and standard deviation for all the features for diabetic patient.

Table 1 : Mean and standard deviation measurement of all the features

FEATURES	MEAN	STD
Integrated EMG	-59.609	503.9653
Mean Absolute Value	246.3694	132.842
Modified Mean Absolute Value 1	187.0663	102.1839
Modified Mean Absolute Value 2	124.7915	69.9963
Mean Absolute Value Slope	-3.313	36.7025
Variance of EMG	5.24E+06	7.33E+06
Root Mean Square	0.01	0.0059
Waveform Length	3.77E+04	2.08E+04
Zero Crossing	32.125	9.4582
Slope Sign Change	58.1528	6.9995
Willison Amplitude	97.4556	0.7376
Autoregressive Coefficients	2.58E+07	3.64E+07
Modified Median Frequency	1.68E+03	1.01E+03
Modified Mean Frequency	486.8818	11.2808

The given table 2 shows the mean and standard deviation for all the features for diabetic patient.

FEATURES	MEAN	STD
Integrated EMG	288.6233	852.8137
Mean Absolute Value	439.7441	237.7973
Modified Mean Absolute Value 1	333.7233	180.5012
Modified Mean Absolute Value 2	221.8945	119.6891
Mean Absolute Value Slope	-1.441	75.8474
Variance of EMG	1.65E+07	1.83E+07
Root Mean Square	0.00116	0.0081
Waveform Length	6.97E+04	3.72E+04
Zero Crossing	31.767	13.7266
Slope Sign Change	5.94E+01	7.83E+00
Willison Amplitude	97.196	0.945
Autoregressive Coefficients	8.11E+07	8.92E+07
Modified Median Frequency	3.07E+03	1.62E+03
Modified Mean Frequency	4.81E+02	1.08E+01

VII. Feature Extraction Stage

In this section the feature extraction and classification steps and their outcomes are presented

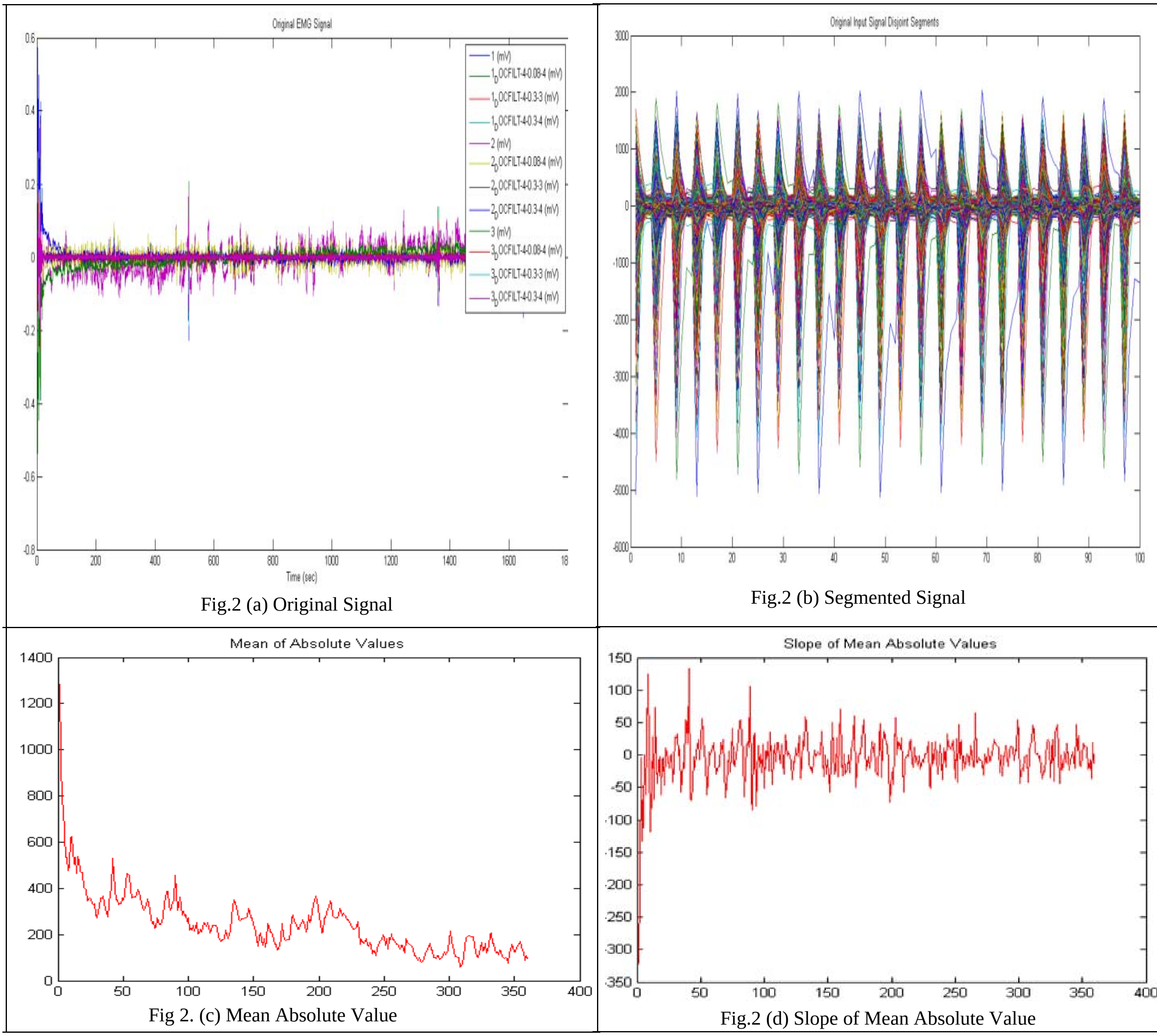

Fig.2 (a) Original Signal

Fig.2 (b) Segmented Signal

Fig 2. (c) Mean Absolute Value

Fig.2 (d) Slope of Mean Absolute Value

Figure 2 : Segmentation & Mean calculation of Raw EMG Signal

The given figure 2 shows the EMG signal processing and feature extraction using our proposed method. Fig 2(a) is the raw signal taken from the electrodes. Fig 2(b) is the segmentation of the raw signal in samples. Fig 2(c) presents the Mean absolute value. In fig 2(d) Slope of Mean Absolute Value.

The next step is to combine all the features in to one matrix for the classification. In our method for non-diabetic user we have assigned class as 0 and for diabetic user class 1 has been assigned. The extracted features combined into one matrix and passed to the SVM classifier for the training the data. After finishing the training step, data is parsed to the prediction stage to get the classification results.

Finally, confusion matrix of classification, precision and recall, specificity and sensitivity of the proposed system are calculated.

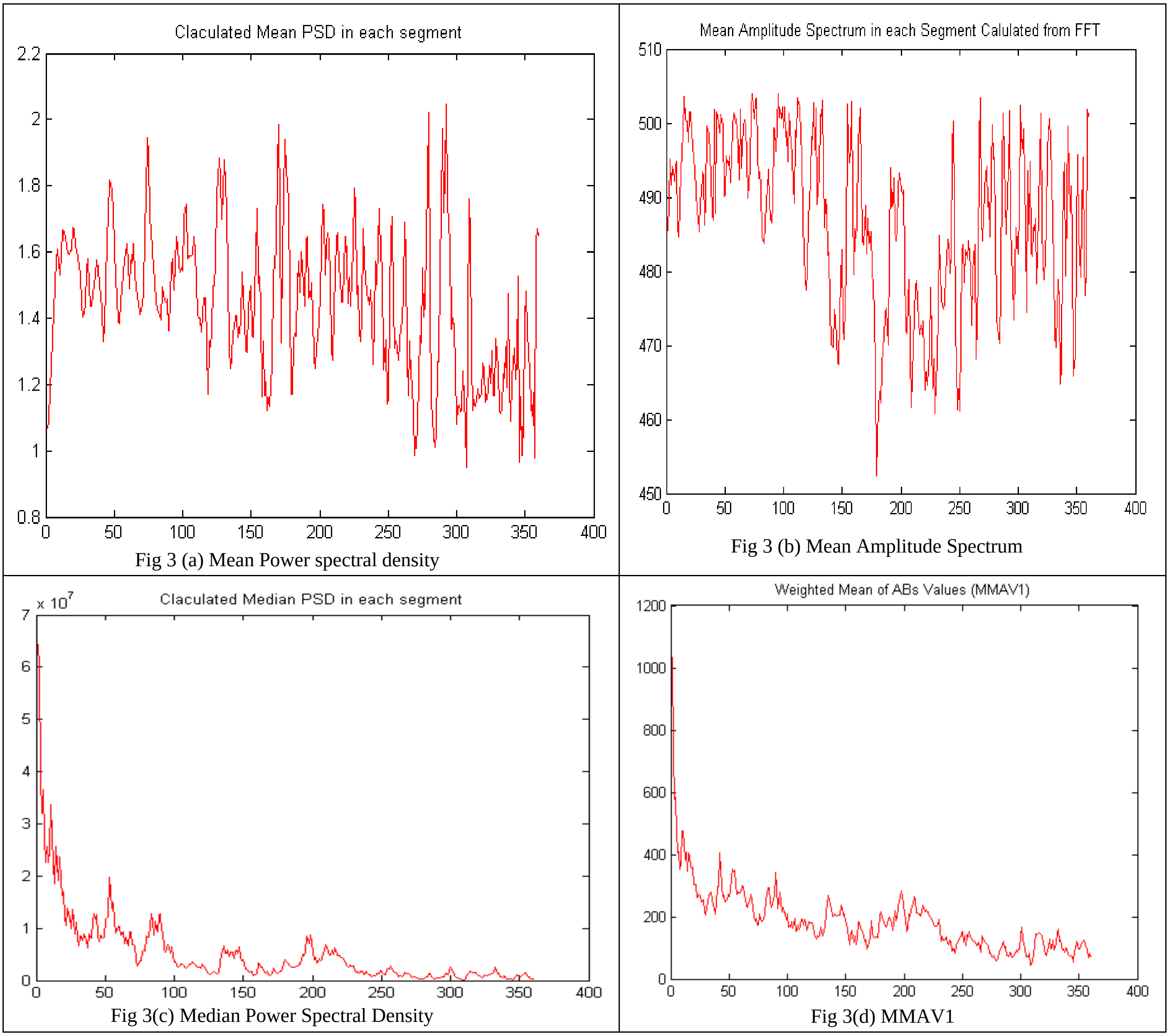

Fig 3 (a) Mean Power spectral density

Fig 3 (b) Mean Amplitude Spectrum

Fig 3(c) Median Power Spectral Density

Fig 3(d) MMAV1

Figure 3 : Power Spectral Density and Weighted Mean calculation

The given figure 3 shows the EMG signal Power Spectral Density and Weighted Mean calculation. Fig 3(a) is the mean of power spectral density. Fig 3(b) is the amplitude of mean which is calculated from FFT. Fig 3(c) presents the power spectral density of the median data of the Raw EMG. In fig 3(d) presents the weighted mean of absolute values which is denoted by MMAV1.

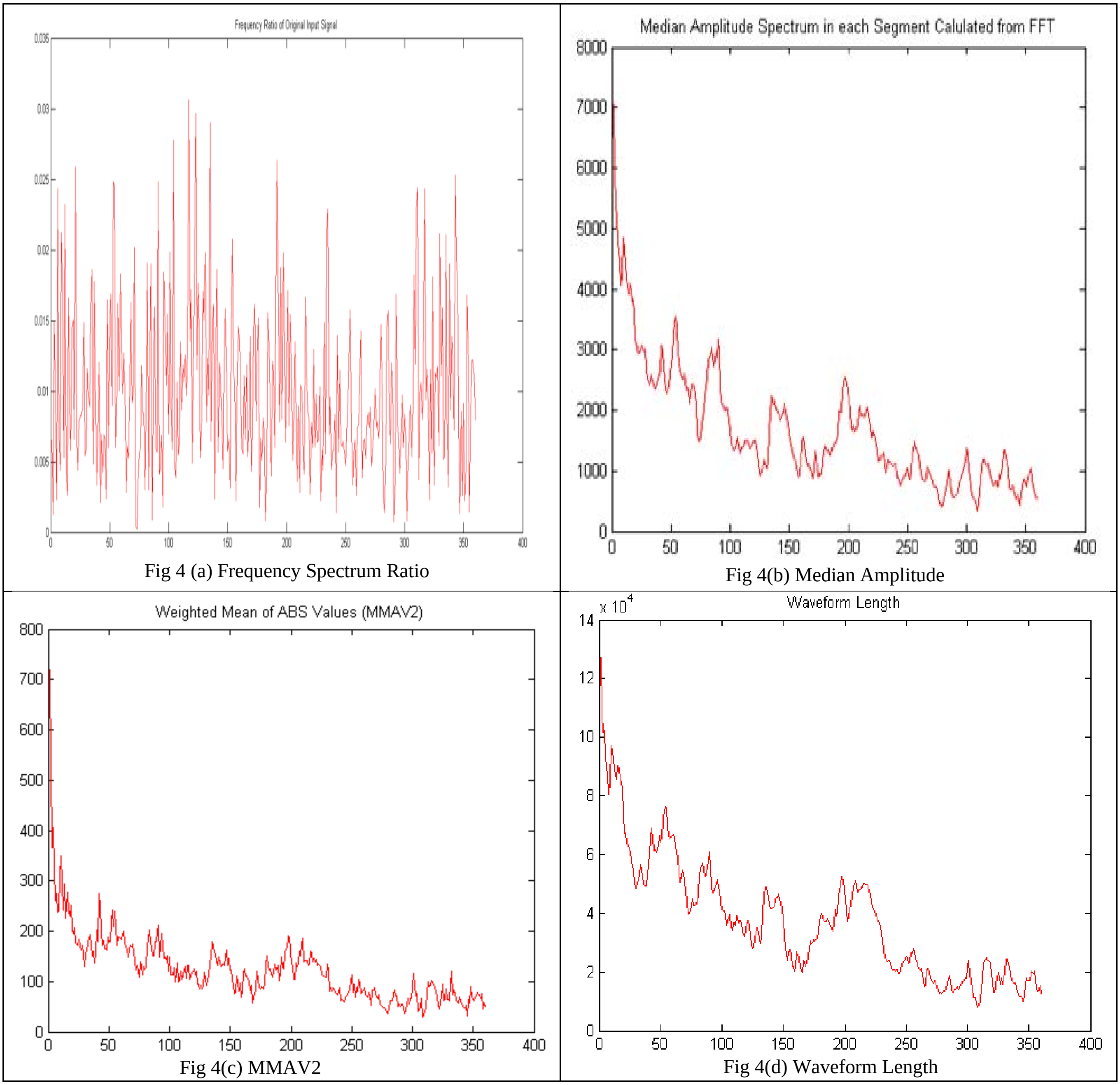

Fig 4 (a) Frequency Spectrum Ratio

Fig 4(b) Median Amplitude

Fig 4(c) MMAV2

Fig 4(d) Waveform Length

Figure 4 : Frequency Spectrum, median amplitude, mean absolute value and Waveform length calculation

The given figure 4 shows the EMG signal Frequency Spectrum, median amplitude, mean absolute value and Waveform length calculation. Fig 4(a) is the frequency ratio of the Raw EMG. Fig 4(b) is the amplitude of median which is calculated from FFT. In fig 4(c) presents the weighted mean of absolute values which is denoted by MMAV2. Fig 4(d) is the waveform length.

VIII. Classification Stage

This is the final stage of our framework in order to achieve the classification results. In this stage all the extracted feature are given to the SVM Classifier. The first step in the classification stage is to train the dataset based on the features extracted from our feature extraction method. After training the dataset one trained model is created based on the feature. This model contains labels of the dataset, indexes and support vectors.

After creating this process of training; this model is given to the SVM prediction step for the classification of the test dataset. In the prediction model the predicted labels are achieved according to the test and train data. Finally the statistics of SVM Classifier is calculated.

Table 1 : Confusion Matrix

292	3
0	2

The above given table represents the confusion matrix of the classifier. According to our dataset we have 297 user's EMG signals. Out of 297, 2 user are having diabetes and remaining are non-diabetes, as we discussed earlier section that for non-diabetes, the class is assigned as 0 and diabetes is 1. It is clear from the confusion matrix that the proposed system is able to identify the diabetes class. It is showing that 292 users are non-diabetic and 2 users are diabetic patient, the remaining 3 users are the misclassification of the approach.

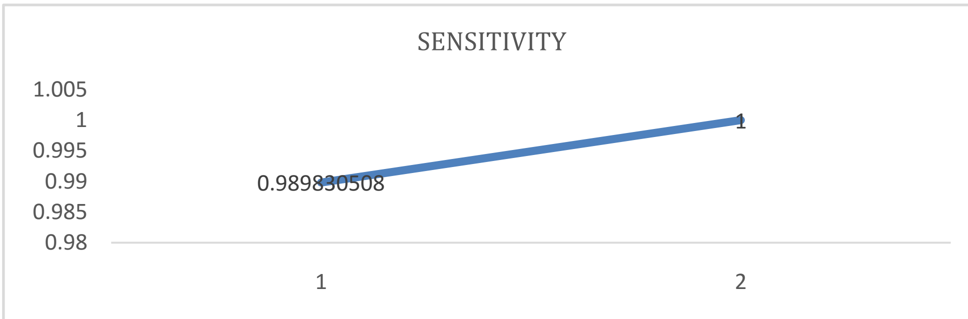

Figure 5 : Sensitivity of the proposed system

In figure 5 another result analysis parameter is plotted which is the Sensitivity of the system. According to this framework, this approach is highly sensitive for the diabetic and non-diabetic class. The x-axis represents the number of class and y-axis represents the sensitivity of the classifier w.r.t the class.

Table 2 : Confusion matrix statistics

RECALL	PRECISION	SPECIFICITY
0.9898	1	1
1	0.4	0.9898

The above given table represents the recall, precision, specificity of the proposed frame work.

$$Precision = TP / (TP + FP)$$

$$Recall = TP / (TP + FN)$$

- Sensitivity (also called the true positive rate, or the recall in some fields) measures the proportion of positives that are correctly identified.
- Specificity (also called the true negative rate) measures the proportion of negatives that are correctly identified.

According to this the precision and recall is calculated for this method.

Total number of users in the dataset is 297 and correctly classified are 294, so the final classification result in terms of accuracy is 98.98%.

IX. Conclusion

The study described the use of the electromyography pattern recognition method, which is very important in different applications, such as rehabilitation devices, prosthetic arm/leg control, assistive technology, symptom detection for neuromuscular disorder, and so on.

In case of a disease monitoring system (i.e. diabetes), two major criteria are applicable—one is robustness and reliability, and another is accuracy of detection. Based on these criteria, the SVM classifier was trained using the extracted features. The experimental results show that the proposed approach is able to classify the diabetes with a better accuracy of 98.9899%.

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Effect of Aerobic Training on Ventricular Remodeling After Percutaneous Coronary Intervention

By Sarah Medhat Mohammed kamel, MSc, Prof. Dr. Zahra Mohammed Hassan Serry, PhD Dr. Hany Ezzat Obaya & Prof. Dr. Osama Al Sayed Abd El Moneem, PhD

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Abstract- Background: Coronary artery disease (CAD) is one of the most common causes of morbidity and mortality in different communities worldwide, and impair the patient's quality of life (QoL). Left ventricular ejection fraction (LVEF) as a clinical index of myocardial contractility and its pumping action is a well established predictor of mortality and long term prognosis in acute myocardial infarction (AMI). Exercise training in post event CAD patients could significantly improve not only the myocardial contractility in terms of LVEF but also could be effectively and safely used with low risk and moderate risk CAD patients. The aim of this study was to determine the effect of exercise training on ventricular remodeling and QoL after percutaneous coronary intervention (PCI).

Keywords: *aerobic exercise, left ventricular ejection fraction, percutaneous coronary intervention, quality of life.*

GJMR-K Classification: *NLMC Code: WB 377*

Strictly as per the compliance and regulations of:

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Sarah Medhat Mohammed kamel [α], MSc, Prof. Dr. Zahra Mohammed Hassan Serry [σ], PhD
Dr. Hany Ezzat Obaya [ρ] & Prof. Dr. Osama Al Sayed Abd El Moneem [ω], PhD

Abstract- Background: Coronary artery disease (CAD) is one of the most common causes of morbidity and mortality in different communities worldwide, and impair the patient's quality of life (QoL). Left ventricular ejection fraction (LVEF) as a clinical index of myocardial contractility and its pumping action is a well established predictor of mortality and long term prognosis in acute myocardial infarction (AMI). Exercise training in post event CAD patients could significantly improve not only the myocardial contractility in terms of LVEF but also could be effectively and safely used with low risk and moderate risk CAD patients. The aim of this study was to determine the effect of exercise training on ventricular remodeling and QoL after percutaneous coronary intervention (PCI).

Subjects and Methods: Sixty patients of both sexes had been recruited from National Heart Institute (NHI), Cairo, Egypt. All patients were within the first year after PCI. They were randomly assigned to 2 groups equal in numbers. Study group was 30 patients (21 men and 9 women, mean age was 52.2 ± 4.9 years) that had been received aerobic moderate intensity exercise training on bicycle ergometer for 50 minutes, 3 times/week, day after day, for 3 months, while control group was 30 patients (20 men and 10 women, mean age was 53.4 ± 4.8 years) that had been received the traditional cardiac care without any exercise training in form of routine pharmacological therapy and lifestyle education. Doppler echocardiography was used to measure LVEF, left ventricle end diastolic diameter (LVEDD) and left ventricle end systolic diameter (LVESD), and Nottingham health profile (NHP) questionnaire was used to measure differences in QoL between both groups. Both measurements were done before and after the study.

Results: After completion of the study, a significant increase was observed in LVEF ($P < 0.05$), without any significant changes in LVEDD and LVESD, also, improvement in QoL were observed in the study group ($P < 0.05$) when compared to control group.

Conclusion: Aerobic moderate intensity exercise training could improve LVEF and QoL after PCI. Aerobic exercise is a good method that improves cardiac contractility and ejection fraction (EF), and did not have adverse effects on LVEDD and LVESD nor cause severe cardiovascular complications.

Keywords: aerobic exercise, left ventricular ejection fraction, percutaneous coronary intervention, quality of life.

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I. Introduction

Coronary artery disease is one of the most common causes of morbidity and mortality in different communities worldwide, and impair the patient's QoL.[1] Various echocardiographic parameters have been shown cardiac dysfunction in CAD patients, such as left ventricular volumes and EF which are strongly related to prognosis of cardiac diseases.[2] LVEF as a clinical index of myocardial contractility and its pumping action is a well established predictor of mortality and long term prognosis in AMI.[3] Many published studies of heart failure patients underwent PCI commonly have a reduced LVEF when compared with normal.[4]

Pooled data from clinical trials have shown significant improvement in LVEF after exercise training in patients after PCI.[5] The Exercise in left ventricular dysfunction study reported that 3 months exercise training improved LVEF significantly in patients after PCI, furthermore, this result was confirmed after 3 months exercise in patients after AMI who had undergone successful PCI. LVEF during exercise was significantly improved.[5] However, exercise training is the core component of cardiac rehabilitation (CR) and secondary prevention of CAD, there is an evidence regarding the effectiveness of exercise training on LVEF in patients with CAD who received PCI, an early (within 1 month post discharge) 12 weeks structured exercise training program in post event CAD patients could significantly improve not only the myocardial contractility in terms of LVEF but also could be effectively and safely used with low risk and moderate risk CAD patients.[4]

It has been widely shown that exercise based CR in patients with AMI and PCI has several beneficial effects on cardiovascular functional capacity, QoL, risk factors modification, psychological profile and mortality.[6]

The degree of ventricular remodelling was regarded as an important prognostic factor associated with cardiac function after AMI, and an increasing number of studies have shown that, in patients with AMI with left ventricular dysfunction, exercise training did not worse ventricular remodelling, and may even prevent this spontaneous deterioration.[7]

In cardiac patients, QoL was evaluated on the basis of objective clinical criteria such as mortality, morbidity, angina, complication rates, test results, or simple indicators such as return to work or repeated hospitalizations.[8] This approach ignored the fact that cardiac disease is a life threatening disease and the operation in itself leads, regardless of the result, to changes in patients' psychosocial and social functioning.[8] It also must be realized that QoL is not only an outcome indicator but may itself be a factor that affects health, illness and coping.[8] Poor QoL has been associated with poorer outcomes, such as lower survival rates, increases in the number of hospitalizations, decreased capacity to perform activities of daily living, and decreased compliance with treatments in other populations like cardiac patients.[9] The most commonly sensitive generic instruments in heart disease are the NHP (used in approximately 40% of studies).[10] The NHP is a well validated test, which has been used previously for assessment of QoL before and after cardiac events.[10]

II. Patients and Methods

This study was conducted in physiotherapy department of NHI, Cairo, Egypt. 60 Patients of both sexes, their ages were 45-60 years old, within the first year after PCI, their BMI was 30- 34.9 Kg/m^2 (class I obesity), were selected and assigned to 2 equal groups in numbers. The study group (30 patients, 21 men and 9 women) that had been received aerobic moderate intensity exercise training on bicycle ergometer 3times/week for 3 months, while the control group (30 patients, 20 men and 10 women) that had been received the traditional cardiac care without any exercise training in form of routine pharmacological therapy and lifestyle education.

Exclusion criteria were patients with Post-infarction, residual myocardial ischaemia, severe ventricular arrhythmias, atrioventricular block, hypertrophic cardiomyopathy, valvular disease requiring surgery, pericarditis, acute systemic illness or fever, severe renal dysfunction (i.e. Creatinine > 2.5 mg/dl), severe orthopaedic problems, such as osteoarthritis of both knees, other metabolic problems, such as diabetes mellitus, acute thyroiditis, hypokalaemia, hyperkalaemia and hypovolaemia.

Before starting the study, a meeting was done for all patients to record demographic data, Doppler echocardiography was used to measure LVEF, LVEDD, LVESD, and NHP questionnaire was used to measure QoL presented with each patient. In that stage a face to face instructions and administration of NHP questionnaire to all participants was given, and if the patient was not sure whether to say "yes" or "no" to a problem, they were instructed to answer the one more true at that time. All patients were taking their prescribed medications by their cardiologists.

Participants in the CR program were requested to attend their exercise program 3 times/week, day after day, for a period of 3 months. Moderate intensity aerobic exercise is prescribed based on Borg's rating of perceived exertion (BRPE) scale. The scale is comprised of 15 points where a rating of 6 means no exertion and a rating of 20 means maximal exertion.[11] Patients are encouraged to achieve a rating between 11 (fairly light) and 14 (hard), with training heart rate (60-70% of maximal heart rate). Target heart rate using karvonen method, taking into account the resting heart rate, is calculated as follows: {[(220-age) or (210-age)-resting heart rate]x(60-70)}+ resting heart rate.[12] For participants in the CR program involved in this study, each exercise session is comprised of 5 to 10 minutes warming up and 5 to 10 minutes cooling down, with active phase of approximately 30 minutes of aerobic exercise training. Aerobic exercise was the dominant mode of exercise which implemented using a bicycle ergometer in the CR program. After 3 months, LVEF, LVEDD, LVESD were measured, and also NHP questionnaire were applied again.

Data were analyzed with SPSS software version 17. The level of significance was set at $P < 0.05$. Paired t-test was applied for each group to compare pre and post values within the same group. Unpaired t-test was applied to compare pre and post values between both groups of the study.

III. Results

Base line measurements had shown no statistical significant differences between both groups ($P>0.05$). The baseline and final values of each group (Table 1) had shown highly significant increase in LVEF ($P<0.000$) in the study group but, LVEDD and LVESD did not change significantly ($P>0.05$). The control group did not show any significant changes in LVEF, LVEDD, and LVESD ($P>0.05$). Results of LVEF were improved significantly in the study group when compared with the control group after the program ($P<0.002$).

As shown in (table 2) the six domains of NHP questionnaire of the study group had improved highly significantly ($P<0.000$). The control group did show significant improves ($P>0.05$). All domains of NHP questionnaire were improved significantly in the study group when compared with the control group after the program ($P<0.05$).

Table (1) : Changes of Echo-parameters from baseline to the end of the study within each group and between groups:

Variables	Study group			Control group			P value for both groups after program
	Pre program	Post program	P Value	Pre program	Post program	P Value	
	Mean ±SD	Mean ±SD		Mean ±SD	Mean ±SD		
LVEF (%)	56.6±6.8	59.6±6.9	0.000*	54.1±5.9	55.9±6.6	0.3	0.002*
LVEDD(cm)	5.01±0.32	5.02±0.31	0.89	5.10±0.20	5.13±0.21	0.6	0.13
LVESD (cm)	3.49±0.43	3.44±0.42	0.13	3.55±0.47	3.47±0.43	0.15	0.71

SD: standard deviation, LVEF: Left ventricular ejection fraction, LVEDD: Left ventricle end-diastolic diameter, LVESD: Left ventricle end-systolic diameter. Significant level: P<0.05.*

Table (2) : Changes of 6 domains of NHP from baseline to the end of the study within each group and between groups:

Variables	Study group			Control group			P value for both groups after program
	Pre program	Post program	P Value	Pre program	Post program	P Value	
	Mean ±SD	Mean ±SD		Mean ±SD	Mean ±SD		
Energy level	51.44±16.06	34.24±15.02	0.000*	47.94±15.99	44.77±15.23	0.44	0.009*
Pain	40.40±21.50	22.17±12.17	0.000*	38.42±23.44	31.95±18.09	0.22	0.02*
Emotional reaction	26.01±13.26	13.75±7.22	0.000*	23.67±13.97	21.07±13.78	0.48	0.02*
Sleep	37.22±13.98	22.30±8.46	0.000*	33.51±17.07	28.96±13.00	0.25	0.02*
Social isolation	37.04±12.10	24.15±9.07	0.000*	34.48±11.76	31.25±11.55	0.31	0.01*
Physical ability	35.29±15.56	20.23±11.55	0.001*	30.64±16.21	27.58±13.53	0.41	0.03*

SD=Standard Deviation, Significant level: P<0.05.*

IV. Discussion

In this study, the LVEF significantly increased from 56.6±6.8 % at the beginning of the study to 59.6±6.9 % after 3 months of CR program (P<0.05), while no significant changes were observed in the LVEDD and LVESD when compared between those at the onset and those at three months after rehabilitation.

Results of the study were supported by Mohammad et al. baseline LVEF in the study group was 46.9 ± 5.9 and in the control group was 47.9 ± 7.0, there was a significant improvement in LVEF after 12 weeks of exercise training in the study group (46.9 ± 5.9 to 61.5 ± 5.3) compared with the control (47.9 ± 7.0 to 47.6± 6.9) group (P=0.001), Also, he concluded that a structured individually tailored home based training program could be as effective as center based programs and safely used not only in low risk but also in moderate risk CAD patients.[4] Agreed with these results, Huan et al. had showed that 6 months exercise training increased LVEF in study group more than controls, and LVESD and LVEDD decreased in the exercise group but increased in the control group, which suggested that, to a certain extent, exercise could prevent ventricular remodeling in patients after AMI.[6]

These findings are in consistent with results from Haddadzadeh et al. that found similar effects with exercise training program in post event CAD patients that significantly improved the myocardial contractility in terms of LVEF.[13] Going with the same line Masoumeh et al. reported that CR had positive effects on patients with EF of about less than 50% that was improved significantly after CR program, Moreover, peak exercise capacity was significantly improved, Also, LVESD and LVEDD had no clinical or statistical change after the program.[2] The results show that, among the patients with LV dysfunction, exercise based rehabilitation is beneficial and has no detrimental effects on ventricular remodeling.[2] Agreed with this study results, Soleimannejad et al. demonstrated that LVEF improved significantly after PCI (with or without the CR exercise program), however, the effect of the CR exercise program on chamber diameters, i.e. LVEDD, LVESD were neutral.[14]

Agreed with these results, Sherin et al. in NHI in Egypt, but in dilated cardiomyopathy patients, there was high statistical significant increase in peak VO2, EF, diastolic dysfunction, resting and maximal heart rates after intervention only in the training group.[15] There was no significant change in any parameter within the control group, as for comparison between both groups; there was high significant difference in peak VO2, resting heart rate and EF after intervention, and the number of patients in the training group with normal diastolic pattern was zero before training, while it was 8 (53.3%) after training.[15] Supporting this study results Giallauria et al. showed that 6-month exercise based CR induced a combined reverse left atrial and LV remodeling as well as significant improvement in exercise functional capacity, LVEF, and early LV diastolic filling.[16]

In contrast to this study results Chul et al. reported that, in a follow up observation of 70 patients diagnosed with AMI from the fourth day of onset for three years, 14 (20%) showed widening in diameter of the left ventricle, a phenomenon that may ultimately cause severe left ventricular failure.[17] Also, they reported that 12 week CR exercise on 13 patients with AMI of around 16 weeks after onset showed reduction in motility of the myocardial wall and LVEF in echocardiography.[17] Also, Kubo et al. investigated the effects of 3 months exercise training on ventricular remodeling after extensive anterior AMI with LVEF $<$ 45% and found that control group patients' LV diastolic volume index and LV systolic volume index improved, but there was no change in the rehabilitation group.[18] Conversely, Otsuka et al. reported that early exercise training did not deteriorate ventricular remodeling in mild, moderate and severe left ventricular dysfunction in his patients.[19] In a similar study by Jiang et al. they reported that LV diastolic diameter increased in the control group, but not in the exercise group, after 3 months' exercise training.[5]

The results obtained in the present study revealed a statistical significant differences in six domains of NHP variables (pain, physical mobility, emotional reactions, energy, social isolation and sleep) between control and study groups ($p < 0.05$) that reflected more improvement of QoL for the study group after CR program. Supporting these results, Marzieh et al. reported that after CR, scores of all physical domains of the short form-36 questionnaire (SF-36) including physical function, physical limitation, body pain, vitality in addition to general health were significantly improved in all patients compared to the baseline and showed that physical activity had influenced QoL, so that increasing physical activity improves QoL.[20] Going with the same line, Arrigo et al. had shown that a comprehensive CR improves QoL even one year after the program.[21]

Supporting these results Babaee et al. had shown significant difference in QoL (by SF-36 and NHP) between study and control group, significant improvements in QoL between two groups, as measured by the NHP, were seen in energy, pain, emotional reaction, sleep, physical mobility and total average quality of life.[22] Significant improvements in QoL between two groups, as measured by the SF-36, were seen in physical function, role limitations resulting from emotional status, role limitations resulting from physical status, mental health, vitality and total average QoL, and demonstrated that health education resulted in improved QoL for patients with CABG.[22] In consistent with the study results, Yohannes et al. investigated the long term effects of a 6 week CR on physical activity, psychological well being, and QoL in 147 cardiac patients. The results demonstrated the benefits of CR in improving HRQoL and physical activity, and in reducing anxiety and depression.[23] Furthermore, these benefits were maintained at 12 month follow up.[23]

However, there were some investigations with different findings; in Serber et al. study, the impact of CR on patients with severe psychological distress was more than others in physical, mental and social aspects of QoL, and showed that QoL was related to primary level of psychological distress of the patients and CR could improve QoL and anxiety just in these group of patients.[24] In contrast Worcester et al. suggested that CR is not sufficiently intensive to influence recovery of QoL.[25] Briffa et al. reported that CR was only found to affect physical function in a recent randomized controlled trial of an 18 session program which compared CR with usual care, but this may be due to short period of his program.[26]

There is a significant and positive relationship between CR and changes in QoL domains. Patients started the study with bad QoL scores and demonstrated significant improvement in QoL scores following the completion of the programme. Likewise, the contractility of the heart increased significantly, physical abilities had increased, they reported feeling less pain and were less limited in activities they did before. According to the reports of the investigators in fields related to the present study, it can be concluded that, all participants's QoL scores and LVEF had improved after the intervention. Exercise based rehabilitation is beneficial to improve cardiac contractility and has no detrimental effects on ventricular remodeling.

V. Conclusion

It was concluded that aerobic training has a positive effects on improving LVEF in post PCI patients, also QoL domains of NHP questionnaire as pain, physical mobility, emotional reactions, energy, social isolation and sleep were improved, further more CR is a good method that improve cardiac contractility and ejection fraction, and did not have adverse effects on LVEDD and LVESD nor cause severe cardiovascular complications.

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The Impact of Low Frequency Ultrasound and Lymphatic Drainage on Triglycerides

By Manar M. Badawy, Nesreen G. Elnahas, Zahra M. H Serry & Basem Alzareef Fouad

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Abstract- The aim of this study is to evaluate the effect of low frequency ultrasound plus lymphatic drainage on blood triglycerides in cardiac patients (chronic coronary atherosclerosis patients with high triglycerides and fat mass body composition. Forty female patients with age ranges from 40 to 50 years were selected from Palestine hospital and they were chronic atherosclerotic patients and were assigned into 2 groups according to their BMI based on the classification of the world health organization. Each patient in the two groups (Group A and Group B) was evaluated before and after 24 sessions treatment program by using the combination of ultrasound and lymphatic drainage machine. The assessment of blood serum triglycerides by UDICHEM-310 ANALYSER have been done before and after the end of 24 sessions and Re-assessment after 2 months from the last treatment session.

Keywords: *low frequency ultrasound; lymphatic system; lymphatic drainage; triglycerides; coronary atherosc-lerosis.*

GJMR-K Classification: *NLMC Code: WN 180, WH 700*

THE IMPACT OF LOW FREQUENCY ULTRASOUND AND LYMPHATIC DRAINAGE ON TRIGLYCERIDES

Strictly as per the compliance and regulations of:

The Impact of Low Frequency Ultrasound and Lymphatic Drainage on Triglycerides

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Abstract- The aim of this study is to evaluate the effect of low frequency ultrasound plus lymphatic drainage on blood triglycerides in cardiac patients (chronic coronary atherosclerosis patients with high triglycerides and fat mass body composition. Forty female patients with age ranges from 40 to 50 years were selected from Palestine hospital and they were chronic atherosclerotic patients and were assigned into 2 groups according to their BMI based on the classification of the world health organization. Each patient in the two groups (Group A and Group B) was evaluated before and after 24 sessions treatment program by using the combination of ultrasound and lymphatic drainage machine. The assessment of blood serum triglycerides by UDICHEM-310 ANALYSER have been done before and after the end of 24 sessions and Re-assessment after 2 months from the last treatment session. The collected raw data of the current patients were statistically analyzed to evaluate the results of the two groups to investigate the effect of using the combination of ultrasound and lymphatic drainage machine on blood serum triglycerides. In this study, the results are revealed statistically significant improvement of blood serum triglycerides before and after the treatment with more improvement had been achieved after 2 months after last session. Furthermore, the low frequency ultrasound technique plus lymphatic drainage technique improve blood serum triglycerides of chronic coronary atherosclerosis patients with high triglycerides and fat mass composition.

Keywords: low frequency ultrasound; lymphatic system; lymphatic drainage; triglycerides; coronary atherosclerosis.

I. Introduction

Triglyceride (TG, triacylglycerol, TAG or triacylglyceride) is an ester derived from glycerol and three fatty acids. Triglycerides are a blood lipid that helps enable the bidirectional transference of adipose fat and blood glucose from the liver. There are many triglycerides depending on the oil source. Some of these are highly unsaturated in the human body; high levels of triglycerides in the bloodstream have been linked to atherosclerosis and by extension, the risk of heart disease and stroke [1].

Hypertriglyceridemia is a prevalent risk factor for cardiovascular disease (CVD) and increasingly important in the setting of current obesity and insulin resistance epidemics. High triglyceride (TG) levels are markers for several types of atherogenic lipoproteins. Patients who have hypertriglyceridemia may be at significant risk for CVD even if low-density lipoprotein cholesterol levels are at goal, and therefore warrant treatment that optimizes diet, reduces overweight, and promotes regular exercise [2].

High-risk patients with hypertriglyceridemia, such as those with diabetes, CVD, or metabolic syndrome, may benefit from additional drug treatment aside from a statin to address other lipid abnormalities. In this discussion, we review the role of hypertriglyceridemia and its associated atherogenic lipoproteins in the pathogenesis of atherosclerosis, the relevance of a high TG level as a predictor of CVD, the cardiovascular outcomes from TG-lowering intervention trials, and the current guidelines for treating hypertriglyceridemia [3].

Men and women who have high triglyceride levels >150 mg/dl and a low level of HDL cholesterol <40 mg/dL are characterized by a significantly increased cardiovascular risk. The high triglyceride/low HDL cholesterol phenotype is a hallmark of the metabolic syndrome. The metabolic syndrome is closely associated with insulin resistance and is highly associated with the risk of CHD. It has a greater impact on the incidence of CHD in women than in men [3].

Adipose cells which make up adipose tissue are specialized cells which contain and can synthesize globules of fat. This fat either comes from the dietary fat we eat or is made by the body from surplus carbohydrate or protein in our diet. Adipose tissue is mainly located just under the skin, although adipose deposits are also found between the muscles, in the abdomen, and around the heart and other organs. The location of fat deposits is largely determined by genetic inheritance. Thus it is not possible to affect where we store fat. Nor is it possible to influence from which area the body burns fat for energy purposes [4].

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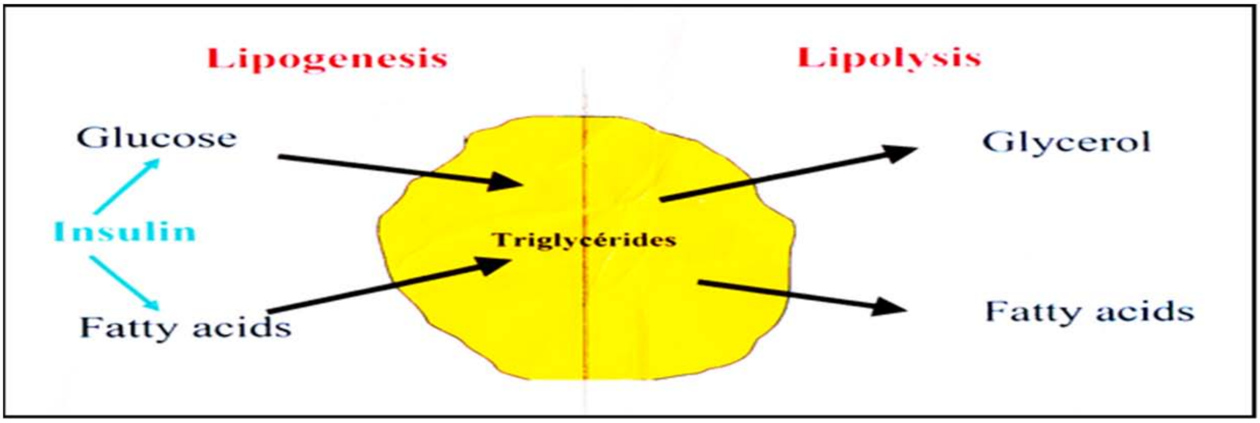

Fig. (1) : Simple composition of adipose tissue

Respective of the location from which they are obtained, the fat cells in humans are composed almost entirely of pure triglycerides with an average density of about 0.9 kilograms per liter. Most modern body composition laboratories today use the value of 1.1 kilograms per liter for the density of the “fat free mass”, a theoretical tissue composed of 72% water (density = 0.993), 21% protein (density = 1.340) and 7% mineral (density = 3.000) by weight [5].

Fat cells are not only energy depots, but are busy endocrine organs. They secrete cytokines, which regulate responses to infection, immune reactions, inflammation and trauma. In regards to inflammation regulation, fat cells secrete pro-inflammatory (TNF, IL-6, and C-reacting protein "C-RP") and anti-inflammatory (adiponectin) cytokines. Unfortunately, with visceral fat obesity accumulation, adiponectin levels are reduced, thus leading to a higher cardio metabolic disorders (e.g., heart disease and diabetes [3].

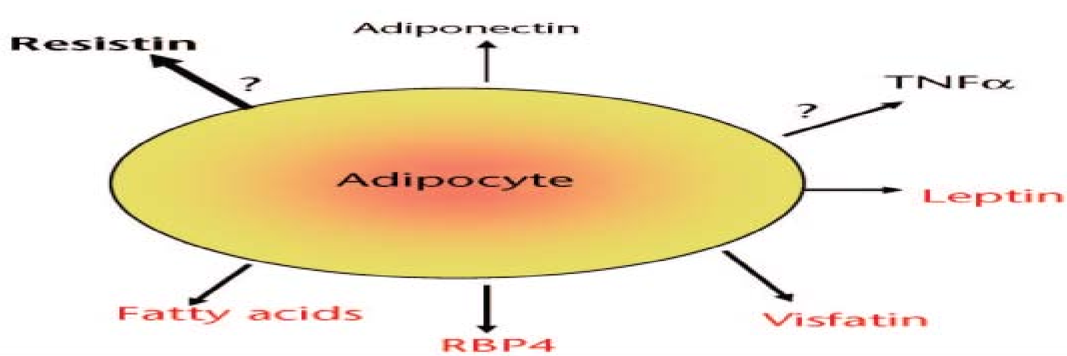

Fig. (2) : Adipocyte tissue

High fat masses especially abdominal obesity is associated with an accelerated atherosclerosis, atherogenic blood triglycerides and other compartments of lipid profile, elevated platelet counts in females with chronic inflammation and increased rates of cardiovascular death [6,7].

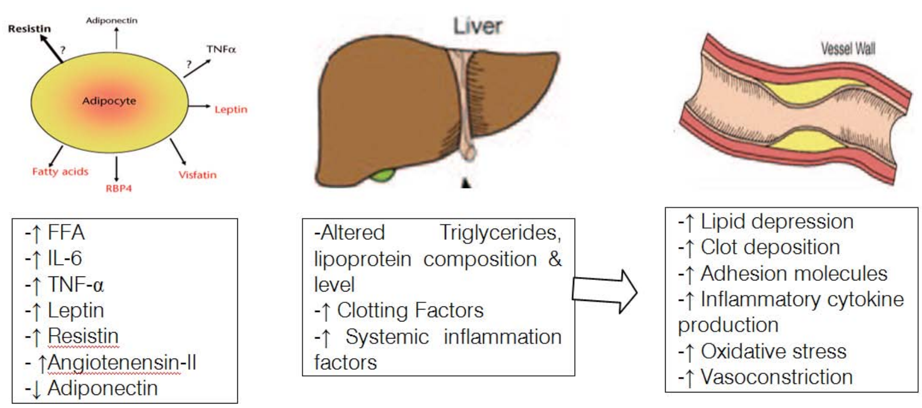

Fig. (3) : Abnormal adipose tissue and atherosclerosis [6,7].

Low intensity low frequency (LILFU) stands for low intensity, low frequency ultrasound. It is a new technique devised by the team of William Tyler from Arizona State University to manipulate neural circuits using ultrasounds. This could make in the future the need of intervention (surgical) neuromodulation unnecessary [8].

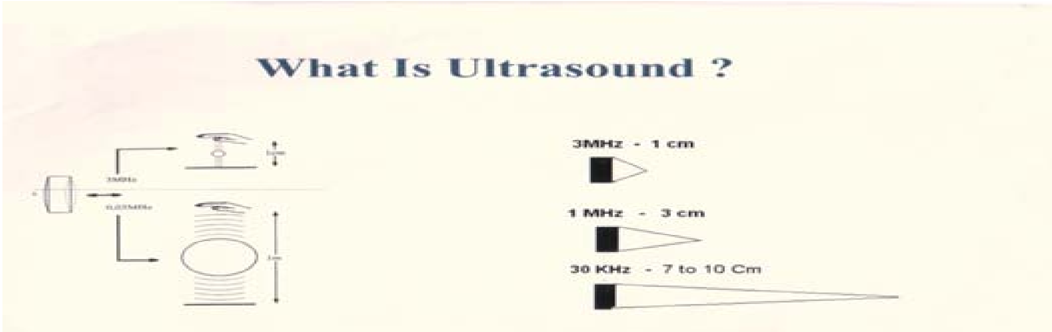

Fig. (4) : The relation between ultrasound frequency and penetration

Cavitation is the process in which a bubble in a fluid is forced to oscillate in size or shape due to some form of energy input, such as an acoustic field. Such cavitation is often employed in ultrasonic cleaning baths and can also be observed in pumps, propellers [8].

Lymph carries away large particles bacteria, Cell debris which can then be filtered out and destroyed by the lymph node Lymph capillaries in the interstitial spaces have same structure as blood capillaries but their walls are more permeable to inter stitial fluid constituents [9].

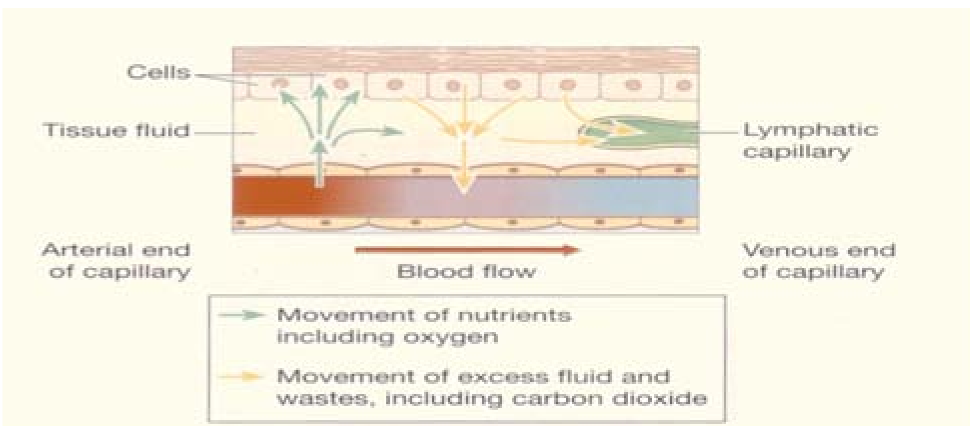

Fig. (5) : Diffusion of nutrients and waste products between capillaries and cells [9].

While lymph is in many instances, a fluid rich in emulsified lipids, it is interesting to note that fat deposition has a tendency to develop first along lymphatic structures, as it very clearly occurs around mesenteric lymphatics and lymph nodes (Figure (1)). Moreover, nearly all lymph nodes are embedded in adipose tissue and most peripheral adipose depots contain one or more lymph nodes as well.44. However, whether there is a causal relationship between lipid content in the lymph and fat deposition is not known [10].

What seems to become clear, however, is that lymph stasis and / or fluid leakage from lymphatic vessels may promote fat accumulation.45 In our experience, when intestinal lymphatic drainage was interrupted by heat cauterization of guinea pig mesenteric vessels, an obvious increase in mesenteric adipose tissue deposition occurred over a 28-day period.46. This observation is reminiscent of what occurs during lymphedema, where lymphatic drainage is disrupted or malfunctioning [11].

The fatty acids found within lymphocytes of lymph nodes upon stimulation come mainly from triacylglycerol's in the immediately adjacent perinodal adipose tissue, which contains more polyunsaturated fatty acids than fat further from lymph nodes [10].

The relationships between the lymphatic system, adipose tissue, lipids profile and immune response /inflammation are undeniable. Our current understanding of the cross-talk between these systems and illustrates how disturbance of these interactions may contribute to the pathogenesis of many disease [11].

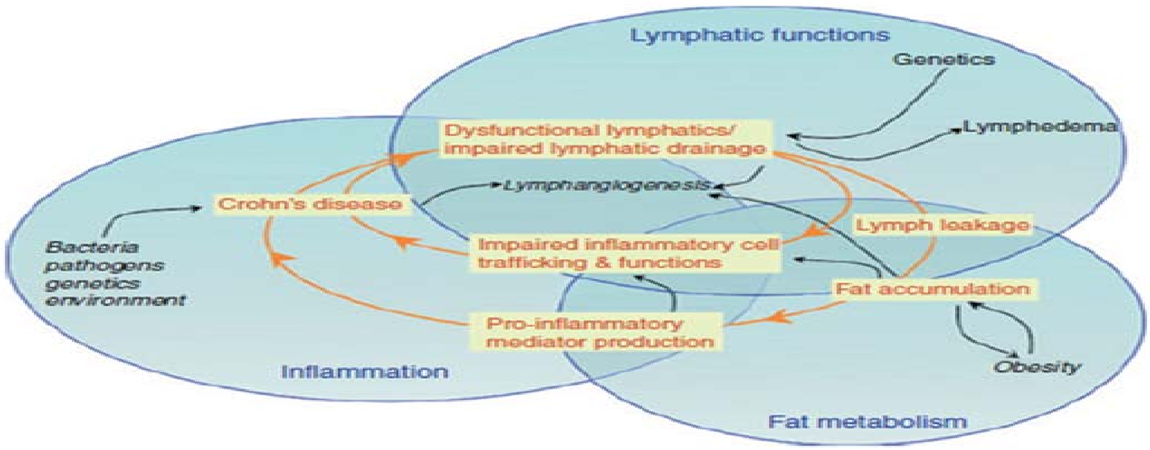

Fig. (6) : Proposed working model for the interactions between lymphatic, fat and inflammation [11].

As the lymphatic system is the platform for the immune system and lymph nodes are the sites of adaptive immune responses modulated by the surrounding adipose tissue, increased knowledge of how the lymphatic system contributes to triglycerides transport, distribution and metabolism and to the pathogenesis of chronic inflammatory conditions may provide the basis for the development of new therapeutic strategies and increased quality of life [11].

II. Methods and Procedures

a) Participants

The study was carried on 40 female patients with age ranges from 40 to 50 years were selected from Palestine hospital, They were obese atherosclerotic patients and were assigned into 2 groups according to their BMI based on the classification of the world health organization, Each patient in the two groups (class I and class II) was evaluated before and after 24 sessions treatment program by using the combination of ultrasound and lymphatic drainage machine. The assessment of blood serum triglycerides by UDICHEM-300 Chemistry Analyzer have been done before and after the end of 24 sessions and Re-assessment after 2 months from the last treatment session.

Group (A): Class II obesity 20 patients with BMI ranged between (35 – 39.9) kg/m^2

Group (B): Class III obesity 20 patients with BMI ranged between (≥ 40) kg/m^2

All patients signed a consent sheet before participation in the study.

b) Procedures

i. *Evaluation equipment's and Procedure*

- Weight, height are measured by using weight, height scale
- Measurements were performed while the patients standing erect back and knees extended and both upper limb beside the body

Measurement of fasting Blood sample: Tourniquet, disposable plastic syringes to draw venous blood samples from antecubital vein in to polypropylene tubes, and then blood glucose and blood lipid profile were assessed through laboratory investigations, figure.

Fig. (7) : UDICHEM-300 Chemistry Analyzer

- Blood sample will be collected and investigated in the laboratory before and immediately after the treatment course and re-estimated two months late.

A three milliliter-sample of venous blood was drawn from the antecubital vein after 12- 14 hours fast from all patients before the initiation of the training program and after the completion of the study (i.e. at the end of the 24 sessions) and re-assessed 2 months after the end of the program to be assayed for measurement of serum level of fasting Triglycerides.

Fig. (8) : Polypropylene tubes showing its gel contents

ii. *Procedure of the Treatment*

Preparation of the patient:

- The purpose and the procedures of the study were thoroughly explained to the patient.
- Assessment of weight, height and serum triglycerides before and immediately after the treatment course and re-estimated two months later.
- A-Low Frequency Ultrasound Application
    - General application of the ultra sound including abdominal area, upper arms, thigh and hips from supine position , Scapular area , posterior aspect of the hips from prone position
    - Duration of the treatment was 20 minutes. The pulse duration was 200 msec. Freq. low frequency 28-31 KHz low intensity. Stimulation mode (20sec. stimulation, 20sec pause).
    - 22 rectangular electrodes (60 x 130)mm. Lip sound machine VLS3. Good stabilization of electrodes was obtained throughout the session. Usage of ultrasound gel for all electrodes.

Fig. (9) : Low Frequency Ultrasound Machine

Fig. (10) : Low Frequency Ultrasound Machine Electrodes

Vacuum Pressure Machine for lymphatic drainage

Vacuum pressure was applied for 20 minute (Starvac vacuum massage 866-312-7540 low power consumption 200W) cyclical vacuum starting from 80 mill bars, (roller methods). General application of the ultra sound including abdominal area, upper arms, thigh and hips from supine. Scapular area, posterior aspect of the hips from prone position. Duration of the treatment was 20 minutes.

Treatment session was applied 3 times a week for two month and each session included lipo sound lymphatic drainage technique.

Fig. (11) : Vacuum massage machine

Fig. (12) : Lymphatic drainage technique

III. Main Results

a) *General Characteristics*

The 40 females participated in this study were classified into two groups of equal number:

Class I: include twenty female patients with age ranges from 40 to 50 years old with the mean value of (46 ± 3.77) yrs, the weight ranged from 80 to 100 Kg with the mean value of (98.5 ± 6.67) kg, the height ranged from 150 to 160 cm with the mean value of (158 ± 5.06) cm. The BMI ranged from 35 to 39.9 kg/m2 with the mean value of (38. 3 ± 1.98) kg/m2 as shown in Table (1) and Figure (1).

Class II: include twenty female patients with age ranges from 40 to 50 years old with the mean value of (45 ± 3.01) yrs, the weight ranged from 110 to 120 Kg with the mean value of (110.5 ± 5.55) kg, the height ranged from 155 to 165 cm with the mean value of (155 ± 4.44) cm. The BMI ranged from > 40 kg/m2 with the mean value of (44.5 ± 3.22) kg/m2 as shown in Table (3) and Figure (44).

Table (1) : The mean values within the two groups.

Variable	Groups	Mean ± SD	median	Max - Min	t-value	p-value
Age (years)	Class I	46 ± 3.77	46	40 – 50	0.56	0.889 NS
	Class II	45 ± 3.01	45.5	40 - 50		
Weight (Kg)	Class I	98.5 ± 6.67	90	80 - 100	1.011	0.765 NS
	Class II	110.5 ± 5.55	114	110 - 120		
Height (cm)	Class I	158 ± 5.06	155	150 – 160	1.209	0.433 NS
	Class II	155 ± 4.44	160	155 – 165		
BMI (kg/m^2)	Class I	38. 3 ± 1.98	37	35 – 39.9	0.97	0.766 NS
	Class II	44.5± 3.22	47	> 40		

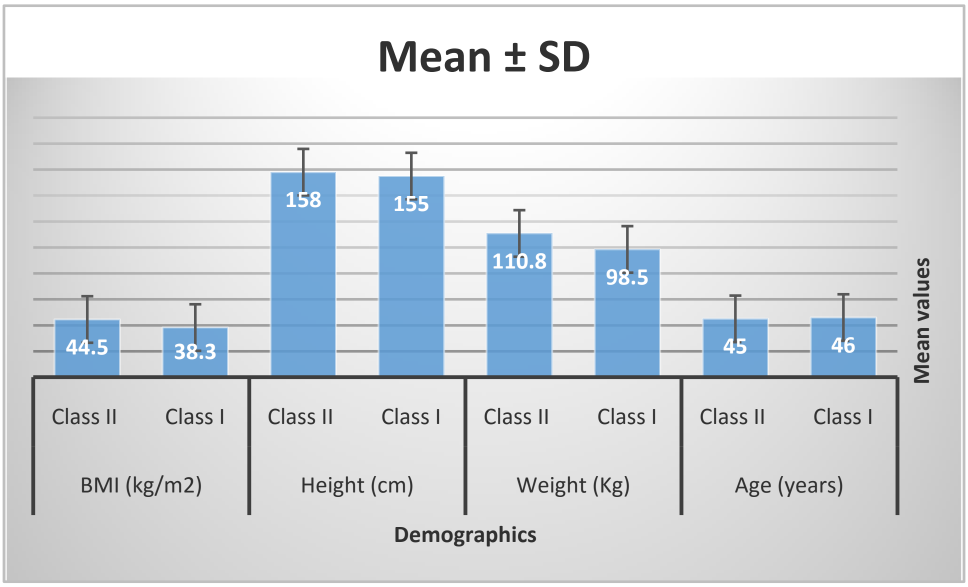

Fig. (13) : The mean values within the two groups

b) Total Body Triglycerides

To determine the differences in the mean values of total body triglycerides among the groups, repeated measure analysis of variance (AVOVA F-Test) was performed as shown in Table (1) showed the f-test result.

Table (2) : Comparing the mean values of total body triglycerides among the two groups.

	Total Body Triglycerides	Mean ± SD	ANOVA Table					
				Sum of Squares	DF	Mean Square	F	Sig
Class I	Pre treatment	267.78 ± 34.34	Between Groups	8767.492	2	4383.746	3.973	.024
	Post treatment	245.01 ± 32.79	Within Groups	62900.358	57	1103.515		
	Post II treatment	240 ± 32.49	Total	71667.850	59			
				Sum of Squares	DF	Mean Square	F	Sig
Class II	Pre treatment	300.29 ± 66.12	Between Groups	15220.133	2	7610.0665	3.443	.038
	Post treatment	268.39 ± 57.22	Within Groups	125999.91	57	2210.5248		
	Post II treatment	264.89 ± 61.15	Total	141220.05	59			

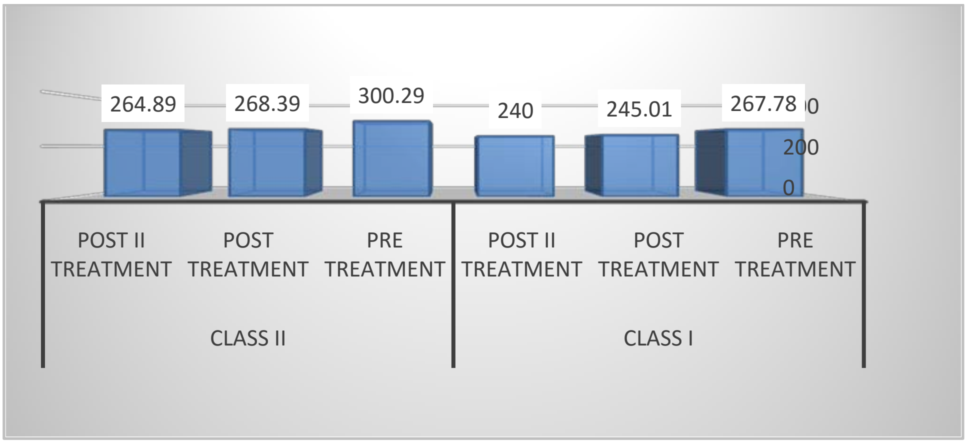

Fig. (14) : Comparing the mean values of Total Body Triglycerides among the two groups

The results of the class I and class II groups revealed that, there is a significant improvement (reduction) in the Total Body Triglycerides for the subjects at the three stages of the measurements (Pre, Post, and Post II). Accordingly to ANOVA F-test should be followed by the Post-Hoc LSD method to identify which group has the significant differences.

In the following table, class I results shows that Pre-treatment is significantly different from Post treatment and Post II.

Table (3) : The mean value of the three measurement of Total body Triglycerides

Variable Total Body Triglycerides	Mean Difference	Significance
Pre, Post	22.765*	(0.034) S
Pre, Post II	22.78*	(0.011) S
Post, Post II	5.015	(0.635) NS

In the following table, Class II results shows that Pre-treatment is significantly different from Post II treatment only.

Table (4) : The mean value of the three measurement of Total body Triglycerides

Variable Total Body Triglycerides	Mean Difference	Significance
Pre, Post	31.9	(0.098) NS
Pre, Post II	25.049	(0.029) S
Post, Post II	3.5	(0.854) NS

IV. Discussion

This study was conducted to assess the responses of serum Triglycerides to a treatment program by using the combination of ultrasound and lymphatic drainage machine in chronic atherosclerotic patients, The results showed that there were significant difference in Serum Triglycerides that is strongly correlated with the reduction of the body fat mass studied earlier in the first part of our research

With respect to Dennis Jones and Wang Min [12] with the emergence of lymphatic-specific markers, further characterization of the underlying molecular mechanisms for lymph angiogenesis may provide a therapeutic avenue for selective inhibition of lymphatic vessels in diseases such as cancer. On the other hand, stimulation of lymph angiogenesis may be beneficial in diseases of lymphatic insufficiency. Additional study of lymphatic vessel regulation will yield further insight into recent implications of their contribution to transplant rejection, obesity, hypertension, and other metabolic and inflammatory disorders.

Results of this study agreed also with Dennis Jones and Wang Min [12] who stated implications of lymphatic stimulation on obesity, hypertension, and other metabolic and inflammatory disorders. As Lymphatic drainage, techniques improved the level of Triglycerides and Fat mass in chronic atherosclerotic cases.

Moreover, Palumbo P1 et. al. [13] effects of a new low frequency, high intensity ultrasound technology on human adipose tissue ex vivo were studied. In particular, they investigated the effects of both external and surgical ultrasound-irradiation, in our experimental conditions, both transcutaneous and surgical ultrasound exposure caused a significant weight loss and fat release. This effect was more relevant when the ultrasound intensity was set at 100 % (~2.5 W/cm^2, for external device; ~19-21 W/cm2, for surgical device) compared to 70 % (~1.8 W/cm^2 for external device; ~13-14 W/cm2 for surgical device), the effectiveness of ultrasound was much higher when the tissue samples were previously infiltrated with saline buffer, in accordance with the knowledge that ultrasonic waves in aqueous solution better propagate with a consequently more efficient cavitation process. On the other hand, the overall effects of ultrasound irradiation did not appear immediately after treatment but persisted over time, being significantly more relevant at 18 h from the end of ultrasound irradiation. and a significant increase mainly of triglycerides and cholesterol.

The data obtained in our study revealed statistical significance changes in fat mass and the significant improvement (reduction) in the Total blood serum triglycerides for the group A (Class I) and, group B class II groups at the three stages of the measurements (Pre, Post, and Post II). revealed that the combination of lymphatic drainage technique with the low frequency ultrasound reduce the Triglycerides rather than using the low frequency ultrasound only and revealed that there is a positive significant correlation between the reduction of fat mass post-treatment and the reduction of the total body Triglycerides.

This also was consistence with Katsunori Nonogakia et. al. [14], they examined the effects of low-frequency and low-intensity ultrasound (800 kHz, 2mW/cm2), Subjects underwent ultrasound irradiation applied to the forearm for 30 min at 800 kHz and 2 mW/cm2 with 100% duty, or placebo irradiation. After treatment for 30 min, BP and pulse rate were again measured using a BP monitoring system, There were no significant differences in age, BMI, serum high-density lipoprotein-cholesterol (HDL-c), low-density lipoprotein-cholesterol (LDL-c), triglyceride (TG), high sensitive-C-reactive protein (hs-CRP), fasting plasma glucose (FPG), HbA1c, systolic and diastolic BP, pulse rate, pulse pressure, CO, TPR, or CI between the placebo controls and ultrasound treatment group Systolic and diastolic BP, pulse rate, pulse pressure, CO, and CI in the ultrasound treatment group, however, were significantly lower than the baseline values in subjects with hypertension, and lower than those of placebo controls.

The present study relayed on objective method of assessment as body composition analysis and Triglycerides evaluation which is considered one of the objective methods that increase the reliability and validity of the study. Results show reduction in Triglycerides that can improve many cardiac cases complications as hyper tension.

V. Conclusion

Low frequency ultrasound plus lymphatic drainage technique can be considered a safe and well tolerated method with no life threatening side effects. LFUS plus LD technique improves the blood serum triglycerides fat mass, fat free mass, body water composition, in different types of cardiac obese patients.

Low frequency ultrasound plus lymphatic drainage as a technique could be used as an alternative to conventional exercise and alternative to many obesity surgery as Liposuction surgery and thus provide an opportunity to improve the quality of obese cardiac patient as many obesity surgery have a lot of hazards and sides effect that may affect the patient especially those with cardiac conditions, and that result could be achieved with the usage of LFUS plus LD technique in order to reduce the blood serum triglycerides, fat cells size and even destruction of adiposities with acceptable penetration and get rid of that cells out of the body preventing hazards and complication as thrombosis and many cardiovascular complicated that can be a result of high blood serum triglycerides and high total body fat mass.

VI. Acknowledgments

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MRI-T1 and T2 Image Fusion for Brain Image using CDF Wavelet based on Lifting Scheme

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Abstract- In the field of medical imaging. Image fusion is an important application for extracting complementary information from different modality. In this work, we propose a fusion algorithm using CDF9/7 wavelet based on lifting scheme with specified fusion rules to combine pairs of multispectral Magnetic Resonance Imaging (MRI) such as T1, T2. The experimental results of brain tumor show that the proposed algorithm preserves both edge and component information and also increases the efficiency of tumor detection. The parameters like mutual information MI, entropy EN, and spatial frequency SF, standard deviation SD are calculated to evaluate performance of proposed algorithm. Finally the results are compared with existing methods.

Keywords: image fusion, multispectral MRI-T1, MRI-T2, brain tumor, CDF9/7 wavelet, lifting scheme.

GJMR-K Classification: NLMC Code: WN 180

MRI-T1ANDT2IMAGEFUSIONFORBRAINIMAGEUSINGCDFWAVELETBASEDONLIFTINGSCHEME

Strictly as per the compliance and regulations of:

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I. Introduction

The medical image has seen an important development in the last two decades such as computed tomography (CT), magnetic resonance image (MRI), positron emission tomography (PET), and single photon emission computed tomography (SPECT). Now, the doctors need information from more than one modality for efficient disease detection and diagnosis. Medical image fusion is the technique of merging images belonging to different modality into a single resultant image that is provide complementary information for better analysis.

Image fusion can be grouped into three categories: Pixel level, Region level and Decision level. There are two approaches for pixel level method: spatial domain and transform domain [4]. Spatial domain fusion techniques are simple and fused image can be obtained by directly applying fusion rules on pixel values of source images such as Simple averaging, PCA (Principal Component Analysis) [5] and linear fusion [6]. But major disadvantage of spatial domain techniques are that they introduce spatial distortions in the fused image [7] and do not provide any spectral information. Transform domain techniques overcome the disadvantages of spatial domain fusion. Pyramid and wavelet transforms based techniques are the mostly used transform domain image fusion methods. Laplacian pyramid [8], contrast pyramid [9]. These methods overcome the disadvantages of spatial domain techniques but suffer from blocking effect [7]. As a result wavelet transform based fusion [11, 12] approaches are used and it was found that no blocking effect occurred during fusion process. Discrete wavelet transform (DWT) [3] and integer wavelet transform [2] preserves different frequency information but may produce specularities along the edges and shift sensitivity, poor directionality and lack of phase information [15, 16]. The third type is new multiresolution methods are proposed, such as image fusion based on nonsubsampled contourlet transform (NSCT) [17]. Due to these limitations of real valued DWT. Another approach uses biorthogonal wavelet CDF 9/7 [18] based on lifting scheme provides better representation of fused image.

The objective of this research is to introduce CDF 9/7 wavelet based on lifting scheme to fuse more properties (edge, information) of different modalities such as MRI-T1 and MRI-T2 brain images (normal and tumor). The proposed algorithm is also uses the specified fusion rules of low and high frequency subbands. Experimental results on the Brain Web database show the usefulness of this wavelet family and clearly indicate its potential in medical image fusion.

The rest of paper organization of this is as follows, the section 2 we present the proposed fusion algorithm steps with fusion rules. The experimental results are shown in section 3 and we compare results obtained with the existing techniques. Finally the main conclusions are summarized in Section 4.

II. Proposed Fusion Algorithm

The input Images can suffer from artifacts due to different factors. However the recent advances in acquisition protocol make it possible to acquire images with very limited artifacts. The proposed method is illustrated in Figure 1

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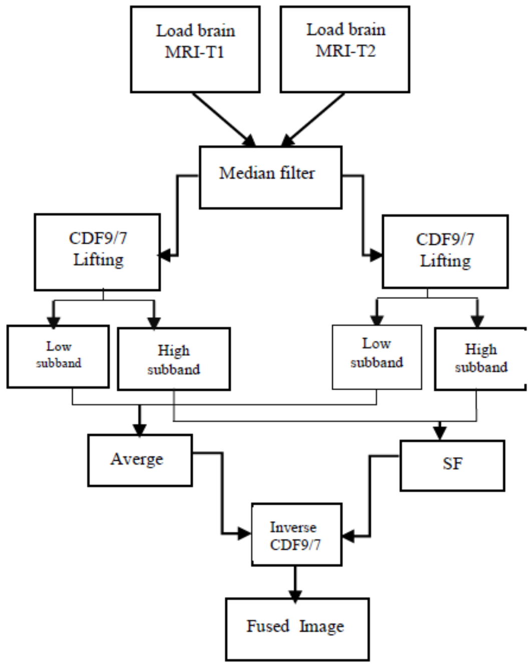


Figure 1 : Block diagram fusion using CDF9/7 lifting wavelet transform (LWT)

a) *Image de-noising using median filter (pre-processing)*

This proposed system describes the information of enhancement using weighted median filter for removing high frequency component which characterize the noise. These filters have the robustness and edge preserving capabilities with noise attenuation characteristics. After the pre-processing operations the input images are subjected to wavelet analysis which is described in the following section.

b) *Biorthogonal CDF9/7 wavelet based on lifting scheme [1]*

Sweldens from Bell Labs proposed a method which does not depend on the Fourier transform of ascension wavelet construction in the mid 1990's presented in [19, 20], where sweldens showed that the convolution based biorthogonal Wavelet Transform (WT) can be implemented in a lifting-based scheme. The lifting-based WT consists of splitting, lifting, and scaling modules and the WT is treated as prediction-error decomposition. It provides a complete spatial interpretation of WT.

In this article we deals with biorthogonal wavelet 9/7, these wavelets are part of the family of symmetric biorthogonal wavelet CDF. The low pass filters associated with wavelet 9/7 have p=9 coefficients in the analysis, p=7 coefficients to synthesize. The wavelets 9/7 have a great number of null moments for a relatively short support. They are more symmetrical and very close to orthogonality [21]. Were the first to show the superiority of the biorthogonal wavelet transform 9/7 for the decorrelation of natural images

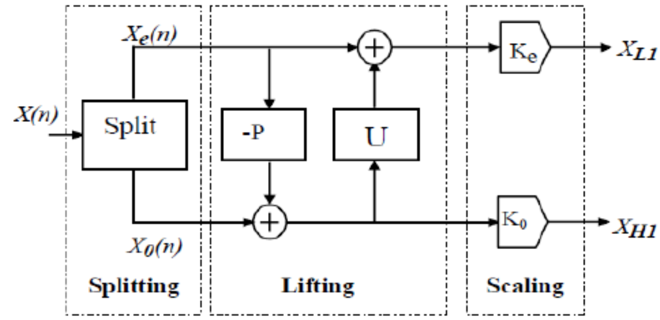


Figure 2 : The Lifting -based wavelet transform

c) *Fusion rules*

The input medical image (A, B) are decomposed using CDF9/7 lifting wavelet transform to obtain the low frequency (LL_A, LL_B) and high frequency (LH_A, HL_A, HH_A, LH_B, HL_B, HH_B) coefficients.

i. *Lowpass subband fusion*

The approximation coefficients are averaged, to preserve the features from both the images

$$LL_F = mean(LL_A, LL_B) \qquad (1)$$

Where LLF is the approximation band of the fused image.

ii. *Highpass subband fusion*

For each detailed sub bands, the spatial frequency is calculated using Equation SF.

$$LH_F = \begin{cases} LH_A & if \quad SF_{LH_A} > SF_{LH_B} \\ LH_B & otherwise \end{cases} \qquad (2)$$

Apply the same technique for: HL_A, HH_A, HL_B, HH_B

Finally, the inverse lifting transform based on CDF9/7 wavelet is applied to generate the fused medical image.

III. Results and Discussion

In this section to evaluate the performance of the proposed algorithm. We fuse normal brain MRI-T1 image with MRI-T2 image from [24] data base. Similarly Brain tumor hypo intense T1 image with hyper intense T2 image are downloaded from [25].

To show the effectiveness of the multi scale transform the comparisons start with PCA (Principal Component Analysis) method, CDF9/7 DWT (discret wavelet transform) based filter banc and CDF9/7 LWT (Lifting wavelet transform) with the first level. To quantitatively compare the performance with existing fusion algorithms, entropy EN, mutual information MI, spatial frequency SF, standard deviation SD and time calcul T , are defined and calculated in the following section. These images were tested on Intel *Core* (I3) 2.13 GHz PC with 2GB of RAM using Matlab 2010a.

a) Entropy

Entropy is the quantity of information contained in a series of events. Entropy is a criterion that measures the level of information in the image, more entropy is large, more diffuse the image information.

$$EN = -\sum_{i=0}^{L-1} p_f(i) log_2 \, p_f(i) \quad (3)$$

b) Mutual Information (MI)

Compares the image source and the fused image, more value is small, the relationship between the two images is non-existent.

$$MI = \sum_{af} P_{AF}(a,f) log \frac{P_{AF}(a,f)}{P_A(a)P_F(f)} \quad (4)$$

$P_{AF}(a,f)$ The joint histogram between fused image F and the source image A.

c) Standard Deviation (SD)

Is the square root of the variance, the variance of an image reflects the degree of dispersion between the grayscale values and the average value of gray levels, more the standard deviation is large, more there are dispersion

$$SD = \sqrt{\frac{\sum_{i=0}^{N-1}\sum_{j=0}^{M-1} F(i,j))}{NM}} \quad (5)$$

d) Spatial Frequency (SF)

It measures the total activity and the level of clarity of an image, an important value mean that the result of fusion is good.

$$SF = \sqrt{RF^2 + CF^2} \quad (6)$$

Where *RF* and *CF* are the row frequency and the column frequency respectively.

The fused image output based on proposed method illustrate in Figure 3 and 4.

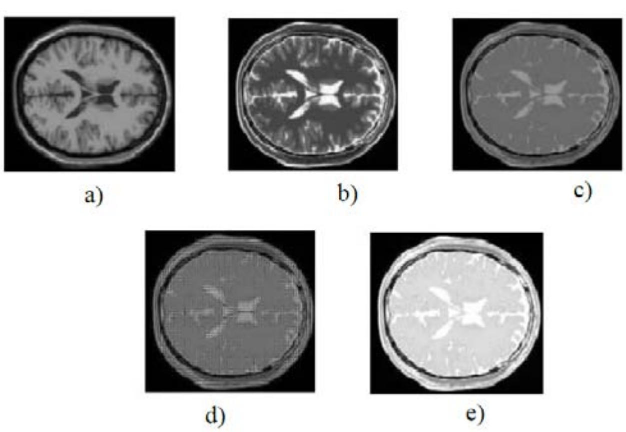


Figure 3 : Fusion results for Normal brain, (a) MRI-T1 image, (b) MRI-T2 image, (c) PCA fusion, (d) CDF9/7 DWT based fusion, (e) proposed fusion method

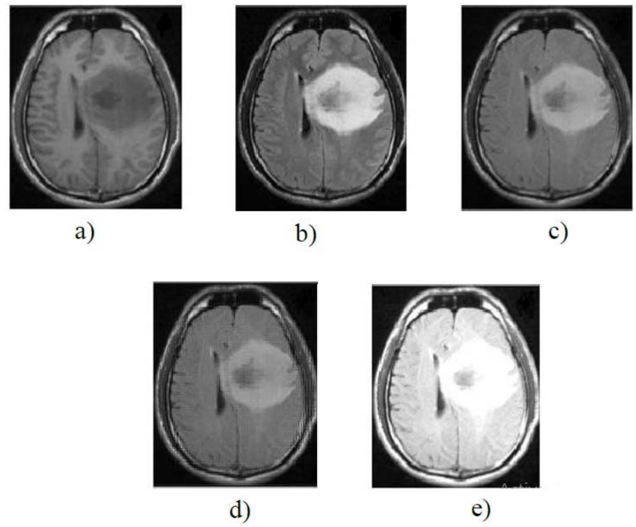


Figure 4 : Fusion results for Brain tumor, (a) brain image with T1 weighting, (c) PCA fusion, (d) CDF9/7 DWT based fusion, (e) proposed fusion method

This visual representation is not sufficient for analysis of the obtained fusion results. Therefore we have compared the proposed method with other ones on quantitative measures which are entropy, standard deviation, spatial frequency, mutual information.

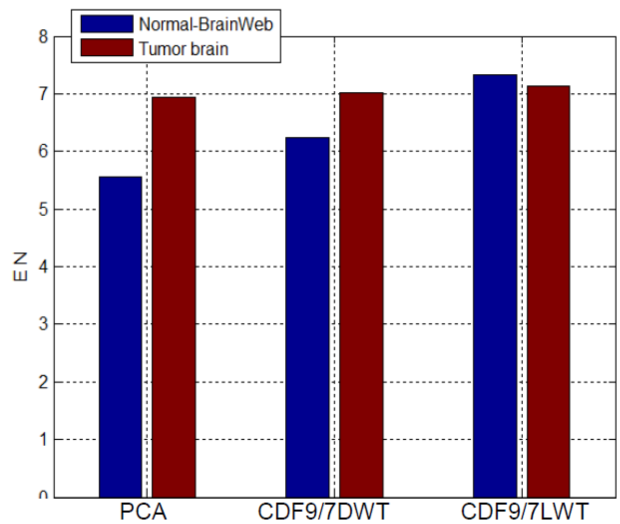
Table 1 : Performance comparison for first set of Brain Web normal database

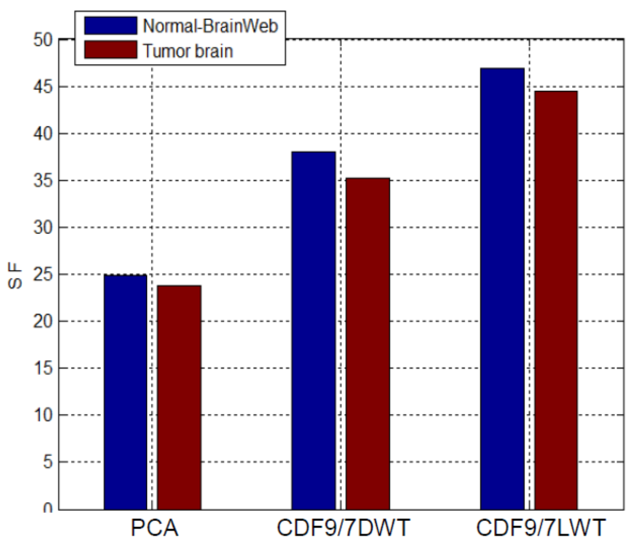
Methods	EN	SF	SD	MI	T(s)
PCA	5.56	24.89	49.77	3.92	1.11
CDF9/7DWT	6.23	38.04	51.10	5.43	1.78
CDF9/7LWT	7.33	46.92	97.84	5.80	1.46

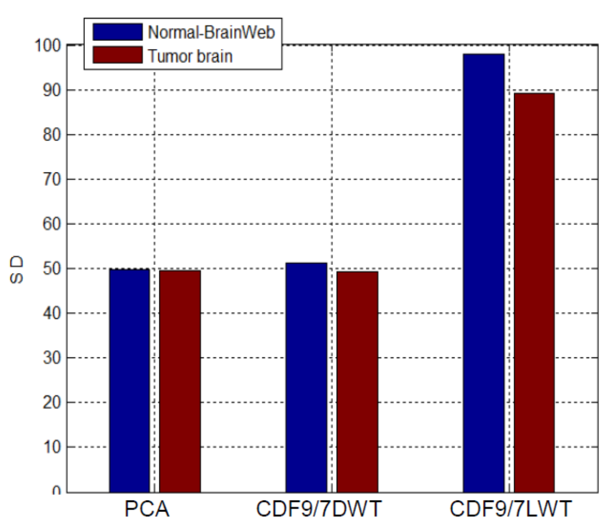
Table 2 : Performance comparison for second set of Brain tumor

Methods	EN	SF	SD	MI	T(s)
PCA	6.93	23.83	49.43	3.20	0.02
CDF9/7DWT	7.01	35.27	49.36	5.85	1.24
CDF9/7LWT	7.12	44.42	89.23	5.98	1.52

For Table1 and 2, The graphical representation of all performance evaluation parameters are showns in figure 5.







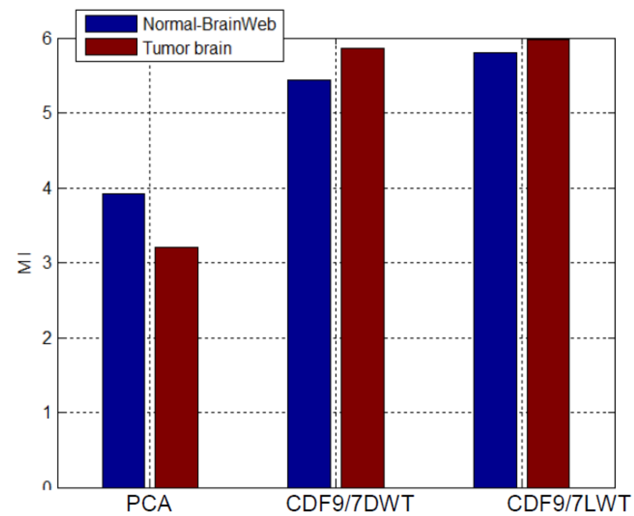


Figure 5 : The graphical of different methods using evaluation parameters

IV. Conclusion

In the present work, we have introduce a new multimodal medical image fusion using CDF9/7 wavelet based on lifting scheme and its essential objective as to retrieve complementary information from different modality to aid doctors for a good diagnosis. The algorithm is evaluated on the Brain Web database and brain tumor. The experimental results showed that the proposed algorithm conserves important edge and spectral information without much of spatial distortion. Finally, these results are compared with different methods (PCA and CDF9/7 DWT based filter banc). In perspective, we plan to extend our study (proposed algorithm) by incorporating learning techniques.

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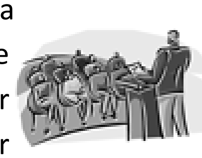

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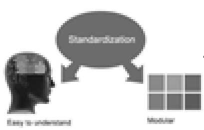

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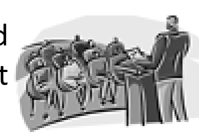

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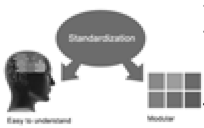

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Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
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References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

Index

A

Adiponectin · 29
Atherogenic · 28, 29
Atrioventricular · 19

C

Cardiopulm · 26

E

Electromyogram · 1, 15

G

Giallauria · 23, 25

H

Haddadzadeh · 21, 25

K

Kolmogorov · 3
Kuribayashi · 3, 14

L

Lymphedema · 31

P

Percutaneous · 17, 25

R

Rheumatological · 1

S

Soleimannejad · 21, 25
Sultornsaneea · 15

T

Tilkemeier · 26
Triglycerides · 27, 33, 36, 37, 38, 39, 40

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