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Radiology, Diagnostic Imaging and Instrumentation

Intermittent Preexcitation

Rural Health-Care Centres

Highlights

T Wave Alternans

Maxillary Sinus in Patients

Discovering Thoughts, Inventing Future

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Intermittent Preexcitation and Electrotonic Modulation of Repolarization as a Cause of Macroscopic T Wave Alternans

By Riyaz Somani, Jane Caldwell & Adrian Baranchuk
Queen's University, Canada

Abstract - Alterations in ventricular depolarization are recognized to lead to inverted T-waves which manifest once the ventricular activation returns to normal. This phenomenon referred to as 'T-wave memory' or 'electrotonic modulation' may be caused by several clinical conditions producing a shift in ventricular depolarization. Currently, T wave alternans (TWA), either macroscopic or microscopic refers to the beat to beat alteration in the repolarization heterogeneity that repeats with every other beat without changes in the QRS complex. We present the case of a 43-year old man with symptomatic intermittent pre-excitation who underwent 24-hour Holter monitoring revealing TWA secondary to electrotonic modulation. It is assumed that this phenomenon does not carry any prognostic significance.

Keywords : intermittent preexcitation; electrotonic modulation; cardiac memory; T wave alternans.

GJMR-D Classification : NLMC Code: QT 34

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Intermittent Preexcitation and Electrotonic Modulation of Repolarization as a Cause of Macroscopic T Wave Alternans

Riyaz Somani [α], Jane Caldwell [σ] & Adrian Baranchuk [ρ]

Abstract - Alterations in ventricular depolarization are recognized to lead to inverted T-waves which manifest once the ventricular activation returns to normal. This phenomenon referred to as 'T-wave memory' or 'electrotonic modulation' may be caused by several clinical conditions producing a shift in ventricular depolarization. Currently, T wave alternans (TWA), either macroscopic or microscopic refers to the beat to beat alteration in the repolarization heterogeneity that repeats with every other beat without changes in the QRS complex. We present the case of a 43-year old man with symptomatic intermittent pre-excitation who underwent 24-hour Holter monitoring revealing TWA secondary to electrotonic modulation. It is assumed that this phenomenon does not carry any prognostic significance.

Keywords : intermittent preexcitation; electrotonic modulation; cardiac memory; T wave alternans.

I. Introduction

Transient changes in the sequence of ventricular depolarization are recognized to give rise to gradual changes in ventricular repolarization which manifests as T-wave inversion. Alterations in ventricular depolarization may be caused by several mechanisms including intermittent ventricular pacing, rate-dependent bundle branch block, tachyarrhythmias with aberrant QRS complexes and ventricular preexcitation. The resultant change in ventricular repolarization remains masked by the secondary T-wave changes induced by the conduction disturbance, and are only unveiled once normal ventricular activation is restored. This phenol-menon is referred to as 'T-wave memory' or 'electrotonic modulation'[1].

Reports on T wave alternans (TWA) refer to the beat to beat alternation in the repolarization heterogeneity that repeats with every other beat with the same QRS complex and has recently been linked with an increased vulnerability to ventricular arrhythmias in certain conditions such as myocardial ischemia, Prinzmetal's angina, states of altered autonomic tone, electrolyte abnormalities and in the long QT syndrome[2]. We present the case of intermittent pre-excitation as the cause of TWA secondary to electrotonic modulation.

Authors α σ : Heart Rhythm Service, Kingston General Hospital, Queen's University, Kingston, Ontario, Canada.

Author ρ : MD FACC FRCPC Associate Professor of Medicine Director, EP Training Program Arrhythmia Service, Kingston General Hospital, Queen's University. E-mail : barancha@kgh.kari.net

II. Case Report

A 43-year old man with symptomatic intermittent preexcitation underwent investigations with 24-hour Holter monitoring. The upper rhythm strip (Figure 1) demonstrates the presence of both preexcited (black arrow) and non-preexcited beats (dotted arrow). In the lower rhythm strip (Figure 1), the corresponding T-wave morphology is seen to alternate with a positive T-wave in the presence of a preexcited beat (grey arrow) and a negative T-wave in the presence of a non-preexcited beat (white arrow). The electrotonic modulation associated with the intermittent preexcitation produced TWA. The patient subsequently underwent an uncomplicated electrophy-siology study with successful radiofrequency ablation of a right mid-septal accessory pathway. Figures 2A (pre-ablation) and 2B (post-ablation) show the development of overt T-wave inversion in leads II, III and aVF (post-ablation of the accessory pathway) in association with normalization of the QRS complex as a manifestation of cardiac memory[3].

III. Discussion

The cellular and electrophysiological basis that gives rise to the T wave observed on a 12-lead electrocardiogram (ECG) remains controversial[4]. Under normal conditions, the concordant polarity of the T wave and the R wave in the surface ECG indicates that the repolarization sequence proceeds in the opposite direction to that followed by the depolarization process[5]. As the direction of ventricular repolarization depends on the course of ventricular depolarization, any shift of the latter results in an instantaneous modification of the T waves, whose spatial orientation tends to be opposite to that of the abnormal QRS complexes. Alterations in the direction of depolarization, through pre-excitation as highlighted in this case, may give rise to changes in ventricular repolarization that are unmasked once normal ventricular activation is restored.

In the present case, the conditioning stimulus giving rise to the altered depolarization, and subsequent repolarization, was only present in alternating beats which consequently resulted in the generation of TWA. TWA has been reported to be associated with an increased vulnerability to ventricular arrhythmias in a

variety of pathophysiological conditions. In the present case, we demonstrate that TWA may be caused by electrotonic modulation associated with intermittent pre-excitation, although there is no suggestion that in this context the TWA seen is of any prognostic relevance.

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Figure Legends

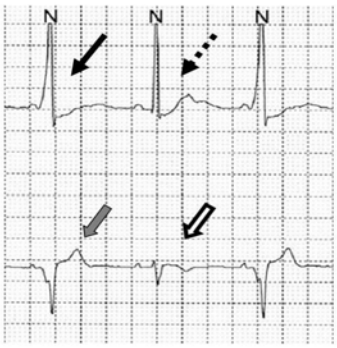

Figure 1

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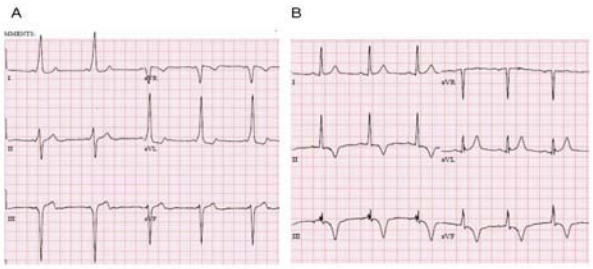

Figure 2

Limb leads pre (A) and post (B) ablation showing the development of overt T-wave inversion in leads II, III and aVF (post-ablation of the accessory pathway) in association with normalization of the QRS complex as a manifestation of cardiac memory.

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Characterization of Maxillary Sinus in Patients with Facial Pain using Ultrasound

By Alsaffi Ahmed Abdalla, Shaza Abdelgafoor Abdelgadir, Caroline Edward Ayad & Amel Gadal

Sudan University of Science And Technology, Sudan

Abstract- *Objectives:* This study dealt with characterization of maxillary sinus in patients with facial pain using ultrasound.

Methods: It was carried out on 50 patients complaining of maxillary sinus problems who were referred to the National Center of Ear, Nose and Throat Khartoum-Sudan. The instruments used were; Aloka SSD 500, Honda HS2000 portable with curvilinear probe 3.5MHz, and General ElectricLOGIQ5 Mobile with curvilinear and linear probe (3.5MHz, 10MHz).

Results: patients were 27males (54%) and 23 females (46%), their ages ranging between (20-70 years) and the most affected age group was the range (20-30years). All of them were of maxillary pain (100%), 28 patients (56%) of halitosis, 29 (58%) postnasal drip, 30 (60%), stuffy nose, 27 (54%) fever and 17(34%) with of malaise. All patients were diagnosed previously by computerized tomography(CT)coronal scans. Ultrasound findings in the maxillary sinuses of the patients were 30% polyps with hypo echoic cavity, 12% fluid with hypo echoic cavity and the posterior margin was seen, 2% showed cyst with hypo echoic area and well defined borders,12% mucosal thickening, 38% normal sonographic appearance of hyper echoic anterior wall and cavity and the posterior margins were not seen, 6% polyps mucosal thickening with hypo echoic cavity with echogenic bony walls.

Keywords : *ultrasound, pain, maxillary sinuses.*

GJMR-D Classification : *NLMC Code: WN 250*

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Conclusion: The study concluded that the ultrasound has sensitivity of 76.6% and specificity of 92.2% and ultrasound is beneficial in diagnosis of maxillary sinus pathology and could be used as one of the diagnostic imaging modality ,as it is non invasive ,easy and with no radiation hazards.

Keywords : *ultrasound, pain, maxillary sinuses.*

I. Introduction

Sinusitis is one of the most common problems affecting the maxillary sinuses. Acute sinusitis may be caused by bacterial infection; Complications of acute bacterial sinusitis (ABRS) may include orbital, intracranial, or soft tissue involvement. Therefore, accurate diagnosis is of major importance and the radiographic imaging is considered as an accurate diagnostic tool.[1]

Authors α ρ ω : *Sudan University of Science And Technology, College of Medical Radiological Science, Khartoum- Sudan.*
E-mail : carolineayad@yahoo.com
Author σ : *National Center of Ear, Nose, Throat diseases and head and Neck surgery Khartoum.*

The American Academy of Pediatrics Clinical Practice Guideline on the management of sinusitis stated that imaging including radiographs, Computerized Tomography(CT) or magnetic resonance imaging(MRI) ;can serve only as confirmatory measures of sinus disease in patients whose clinical histories are supportive of the diagnosis [2]. The American Academy of Allergy, Asthma and Immunology stated that computed tomography (CT) is the preferred imaging technique for pre-operative evaluation of the paranasal sinuses and that ultrasonography has limited utility, but may be applicable in pregnant women and for determining the amount of retained secretions [3]. Coronal computed tomography (CT) scan of the paranasal sinuses was suggested to be considered in the diagnosis of acute sinusitis [4]. The diagnosis of both acute and chronic sinusitis should be made clinically, and not on the basis of imaging findings alone. CT remains the study of choice for the imaging evaluation of acute and chronic sinusitis, in addition magnetic resonance imaging of the sinuses, orbits, and brain should be performed whenever extensive or multiple complications of sinusitis are suspected. In chronic sinusitis, CT scanning is the "gold standard" for the diagnosis and the management, as well as when surgery is necessary. Nuclear medicine studies and ultrasound are rarely indicated in acute and chronic rhinosinusitis [5]. Diagnostic ultrasound is a non-invasive imaging modality that uses high-frequency sound waves. The great variability of test performance of diagnostic ultrasound in acute sinusitis cites systematic evidence [4]. No risks have been identified with ultrasound evaluation of the paranasal sinuses, but the accuracy of the ultrasound is dependent largely on the examiner's skills.[6]

Therefore this study is to assess the role of ultrasound as another tool in diagnosis of maxillary sinuses in patients with facial pain in order to take part in the detection of maxillary sinuses disorders as well as to characterize normal echo texture of different maxillary sinuses diseases as compared to CT; and to correlate between the ultrasound findings with the patients clinical findings.

II. Material and Methods

The study was conducted at the National Center of Ear, Nose, Throat (ENT) and Head and Neck surgery Khartoum-Sudan, in the period from August to November 2011.

a) Study sample

The sample size consisted of 50 Sudanese patients (females and males) between 20 to 70 years old complaining of maxillary pain, and different clinical symptoms. They were previously diagnosed by CT scan and then were investigated by ultrasonography . Patients whose ages less than 20 years old, and more than 70years old, and patients who have no previous CT scans were excluded. No identification or individual details were published.

b) Instrumentations

Ultrasound machines used were Aloka SSD 500 portable with curvilinear probe 3.5MHz, Honda HS2000 portable with curvilinear probe 3.5MHz and General Electric LOGIQ5 Mobile with curvilinear and linear probes (3.5MHz-10MHz).

c) Method

An approval from the review board and ethics committee of the College of Medical Radiological Science was taken .The patients were examined in sitting position; the U/S gel was applied to the area on the face where the sinuses are located, including the nose, cheekbones and maxillary sinuses. High frequency sound waves produced the image of the internal structures, and a highly ultrasound expertise Ear, Nose, Throat(ENT) specialist doctor had done the scan and interpreted the data .The patients were scanned by a frequency ranging from 3.5 to 10 MHz. The data were collected using variable patients complaints and they were diagnosed by U/S and the findings were correlated to CT findings.

To find out the accuracy, sensitivity and specificity of ultrasound(U/S) as compared to the Computed Tomography (CT) diagnosis; equations were applied including :A)For U/S accuracy (True positive cases(TP) +True negative cases(TN) /Total number of cases) X 100.B) For U/S Sensitivity(True positive cases(TP) /True positive(TP) +False negative(FN)X100. C) for U/S specificity (True negative cases(TN) /True negative cases(TN) +False positive cases(FP) X100.

III. Results

The following results were for a sample consisted of 50 patients (23 females and 27 males) all were complaining of maxillary pain. The patients were classified according to age. Patients ages ranged from 20-30 years were 21(42%), 31-40years14(28%), 41-50years5(10%), 51-60 3(6%) years, 61-70 7(14%) (Figure1). The following tables showed the results according to the age, gender, complaints and the ultrasound findings.

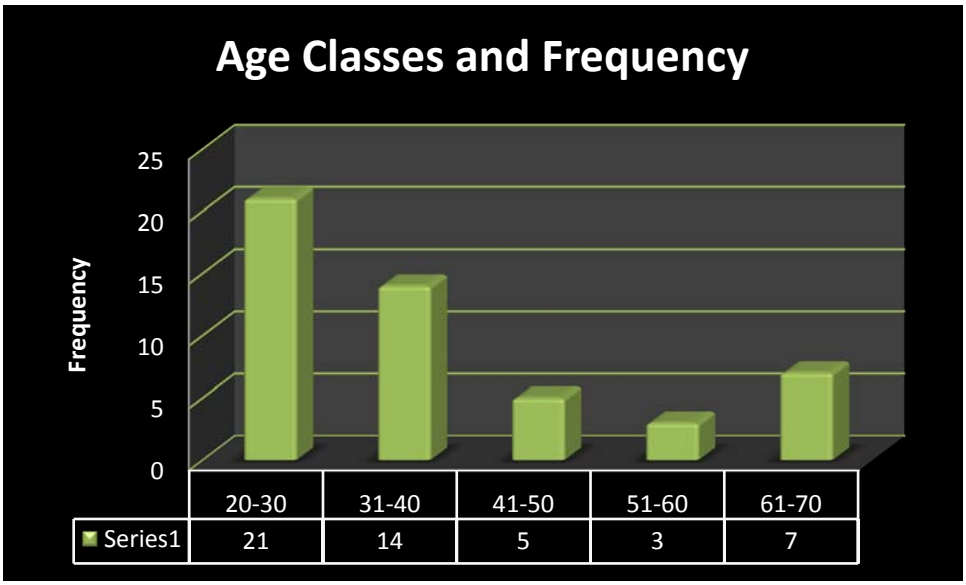

Figure 1 : Age Classes and Frequency

Table 1 : Shows the frequency and percentage of symptoms in the study population

Complains	Number of patients (%)
Fever	27 (54%)
Malaise	17 (34%)
Stuffy nose	30 (60%)
Post nasal drip	29 (58%)
Halitosis	28 (56%)
Pain	50 (100%)

Table 2 : Shows frequency distribution and percentage of ultrasound diagnosis

Ultrasound diagnosis	Frequency (%)
Fluid	6 (12%)
Polyp	15 (30%)
Cyst	1 (2%)
Mucosal Thickening	6 (12%)
Normal	19 (38%)
Polyploidy mucosal thickening	3 (6%)
Total	50 (100%)

Table 3 : Shows the frequency of ultrasound findings according to the patient's gender

Gender	Fluid	Mucosa Thickening	Normal	Polyps	Cyst	Polyploidy mucosal thickening
Male	4	2	12	9	0	0
Female	2	4	7	6	1	3
Total	6	6	19	15	1	3

Table 4 : Comparison of Diagnosis of Maxillary sinuses using Ultrasound and other similar studies

Auther	Ultrasound Sensitivity	Ultrasound Spesifity	Modalities used	Number of Patients
Current Study	76.6%	92.2%	CT and Ultrasound	50
Apostolos H. et al [7]	66.7%	94.9%	CT and Ultrasound	56
Fufezan et al [8]	94.9%	98.4	X-Rays and Ultrasound	67

IV. Discussions

In recent decade, the Health Care Guideline (2011) stated that the diagnosis of acute sinusitis should be based on the presenting symptoms, history, and clinical examination. It noted that plain X-rays for sinus and other imaging tests are usually not necessary in making the diagnosis of acute sinusitis due to their poor sensitivity and specificity limits. Other published studies of ultrasound of the paranasal sinuses do not permit assessment of the sensitivity or specificity of the technique compared to the gold standard of CT scanning. [9]

The Agency for Healthcare Research and Quality (AHRQ) evidence report on Acute Bacterial sinusitis does not address ultrasound of the sinuses [10]

This study assessed the ultrasonography as another tool in the diagnosis of maxillary sinuses disorders in patients with pain in order to analyze whether ultrasonography with a reasonable degree of confidence and can replace radiography in the diagnosis of sinusitis. Fifty patients from the national center of ENT diseases and head and neck center who were previously diagnosed by CT, were investigated by ultrasound, the study showed different maxillary sinus ultrasound diagnosis related to age, gender and complaints.

The frequency distribution was according to gender (table 3), there were 27 males (54%) and 23 females (46%) out of total 50 patients (100%) with maxillary sinus pain. These results support the fact that the males were more affected than females.

The study showed the frequency and percentage regarding to age group (Figure1), the most affected age group was the group (20-30) years constituting 42%.

The frequency and percentage of the patient's complaints (table1) revealed that 50/50 (100%) complain of pain followed by stuffy nose 30/50 (60%) as compared to the other complaints.

The frequency distribution and percentage of ultrasound diagnosis (table 2), clarifies that the normal U/S appearance was found in 19/50 constituting 38%, followed by polyps, mucosal thickening and cysts.

Ultrasonography character and findings of the maxillary sinuses were 30% polyps with hypo echoic cavity, 12% fluid with hypo echoic cavity with posterior margin was seen, 2% cyst with hypo echoic area with well defined borders, 12% mucosal thickening, 38% normal sonographic appearance of hyper echoic anterior wall and cavity and the posterior margins were not seen, 6% polyploidy mucosal thickening with hypo echoic cavity and echogenic bony walls.

From the study, the patients suffered from maxillary pain represented (100%), halitosis (56%), stuffy nose (60%), postnasal drip (58%), fever (54%), and malaise (34%).

When comparing the Ultrasound findings with the CT findings; the study showed that the ultrasound has Sensitivity of 76.6% and specificity of 92.2%

Regarding the results and comparing to what was mentioned by (AHRQ); Ultrasound is proposed for demonstrating mucosal wall thickening, focal soft tissue

masses, and complex collections in the paranasal sinuses.

Ultrasound is a painless non-invasive diagnostic procedure and no risks have been identified with ultrasound evaluation of the paranasal sinuses, but the accuracy of the ultrasound is dependent largely on the examiner's skills and to achieve this purpose; this study was done by a highly experience ENT specialist with ultrasongraphy of excellent performance. The study concluded that paranasal sinus ultrasound has been proposed as best diagnostic imaging modality to confirm the diagnosis of clinical sinuses diseases.

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Development of First Proto-Types of a Low-Cost Computer based Solid-State Spirometer for Application in Rural Health-Care Centres across India

By Pourus Mehta & Vineet Sinha
Bhabha Atomic Research Centre, India

Abstract - India being an emerging economy, it concentrates maximum resources towards indigenization of various technologies making them economically viable to the general population. Presently roughly half of the country dwells in villages and small towns where even basic sanitation and primary health-care facilities are virtually non-existent. Deteriorating environmental conditions have lead to increased susceptibility to various respiratory diseases prompting an early diagnosis from preventive health considerations.

All these factors contribute to a product development philosophy which addresses cost considerations more profoundly in addition to technical accuracy. This paper demonstrates the development of a low cost, portable Spirometer for application in rural health-care centres across India.

First proto-type of a Computer based Spirometer system has been realized employing a solid-state pressure sensor based approach. A dedicated analog signal acquisition and processing channel was designed and tested in tandem with the solid-state pressure sensor. Calibration of the pressure sensor for known values of applied pressure was performed for linearity tests. The 8051 core was employed in designing the micro-controller firmware program for digitization and transmission of the signal to the computer. Dedicated computer software for data acquisition, display and analysis was developed in Lab-windows platform.

Keywords : *pneumotachograph, fleisch type mouthpiece & full vital capacity.*

GJMR-D Classification : *NLMC Code : W 84.6, WN 17*

Development of First Proto-Types of a Low-Cost Computer based Solid-State Spirometer for Application in Rural Health-Care Centres across India

Pourus Mehta[α] & Vineet Sinha[σ]

Abstract - India being an emerging economy, it concentrates maximum resources towards indigenization of various technologies making them economically viable to the general population. Presently roughly half of the country dwells in villages and small towns where even basic sanitation and primary health-care facilities are virtually non-existent. Deteriorating environmental conditions have lead to increased susceptibility to various respiratory diseases prompting an early diagnosis from preventive health considerations.

All these factors contribute to a product development philosophy which addresses cost considerations more profoundly in addition to technical accuracy. This paper demonstrates the development of a low cost, portable Spirometer for application in rural health-care centres across India.

First proto-type of a Computer based Spirometer system has been realized employing a solid-state pressure sensor based approach. A dedicated analog signal acquisition and processing channel was designed and tested in tandem with the solid-state pressure sensor. Calibration of the pressure sensor for known values of applied pressure was performed for linearity tests. The 8051 core was employed in designing the micro-controller firmware program for digitization and transmission of the signal to the computer. Dedicated computer software for data acquisition, display and analysis was developed in Lab-windows platform. A proto-type Fleisch type pneumotachograph (pressure sensor based spirometer) mouthpiece was designed, manufactured and tested in conjunction with the designed setup.

Keywords : pneumotachograph, fleisch type mouthpiece & full vital capacity.

I. Introduction

- Historical Perspective

Indians are genetically at higher risk of developing cardio and pulmonary diseases. Being a developing country, India lacks even basic health-care infrastructure in its far flung rural villages. With the gradual progress in development meaning life-style related diseases like heart-disease, diabetes, renal diseases etc. have taken a toll on the population. Compounding the problems of wide-spread poverty with an increase in life-style related diseases necessitates a greater budgetary allocation needed for providing primary health-care. On an average 30% of Indians suffer from various cardio-vascular & pulmonary diseases. Latest statistics reveal that roughly 27 % of India's population falls under the below poverty line category. With the slow pace of economic growth seen in recent years India has not been able to fund rural health-care and poverty alleviation schemes with generous budgets.

- Objectives

Our research is directed towards bridging the cost divide in providing much needed basic health-care for our less-fortunate countrymen living in rural India. As a precursor to providing diagnostic indicators for various diseases, a Spirometer forms an integral piece of equipment to be installed in village health-care centres across India.

- Comparative Statement

Commercially available Spirometers are expensive to be procured for every village clinic considering there are 5,93,731 villages across the Indian sub-continent. An indigenous initiative to develop diagnostic equipment will go a long way in providing sustained supply of health-care equipment for the country.

- Concept and Realization

Spirometry is the technique of measuring the respiratory function of humans. It is most commonly referred to as pulmonary function tests (PFTs) in diagnostic parlance. PFTs employed for measuring lung function parameters like total lung volume, air flow rate and velocity during the inhalation / exhalation cycles give an indicator of lung muscle integrity. These vital parameters are crucial in diagnosing respiratory diseases like asthma, pulmonary fibrosis, cystic fibrosis, and COPD. The outputs of spirometry are generally referred to as pneumotachographs which contain graphical illustrations of Flow-rate versus Volume, Volume versus time & Flow-rate versus time. Commercially available spirometers in the market are often exorbitantly expensive and not within the reach of

Authors α σ : Bhabha Atomic Research Centre, Electronics Division, MOD Lab, Trombay, Mumbai, India. E-mails : pdmehta@barc.gov.in, vinsin@barc.gov.in, pourus_m@yahoo.com

allow these physicians to make more quantitative assessments of their patients' pulmonary health. A training program that would instruct and motivate patients through the Spirometric tests would further augment the accuracy of clinical diagnosis. Figure 1 example of a test spirogram. The various lung diseases vis-à-vis the indicative figures of Spirometry parameters are enlisted in Table-1.

Table 1 : Tabular form of various diseases versus the indicative (qualitative) figures of Spirometry Parameters

Sr. No.	Diagnosis	Forced Expiration Volume for one second **FEV1** (Litres)	Forced Vital Capacity FVC **(Litres)**	**FEV1/FVC**
1	Normal Person	Normal	Normal	Normal
2	Airway Obstruction	Low	Normal / Low	Low
3	Airway Restriction	Normal	Low	Low
4	Combination of Obstruction / Restriction	Low	Low	Low

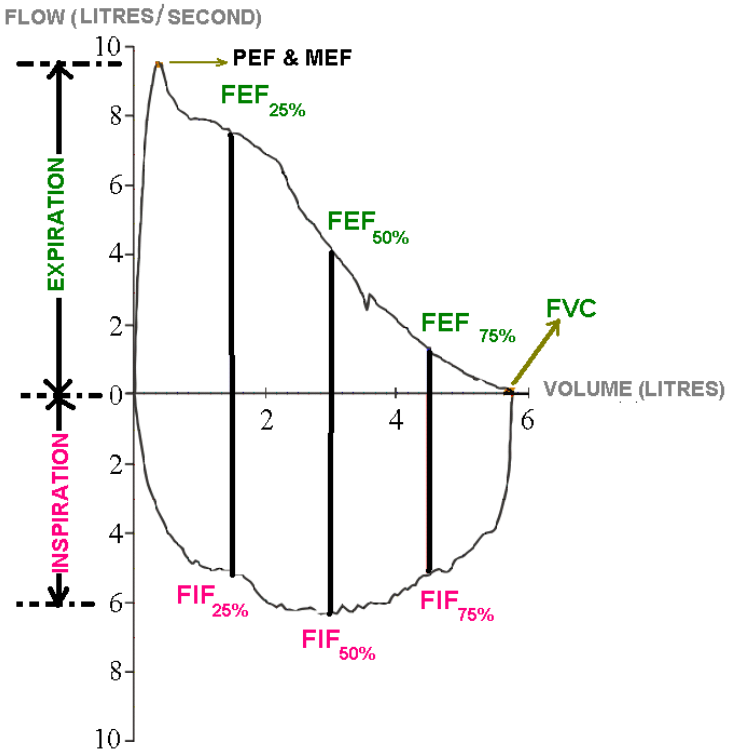

Figure 1: Graphical illustration of a sample Spirogram

SDI Diagnostic, MicroDirect, and Welch Allyn are among some of the commercial manufacturers of spirometers. SDI Diagnostic manufactures six different spirometers ranging from $995 to $2395. The Spirolab II is a top of the line spirometer with salient features touch screen, Bluetooth, and a bidirectional turbine with a rotary sensor with a price tag of $2395. Among the commercial brands MicroDirect spirometers are comparatively affordable with a price of $1419.55. Summarily, nearly all spirometers in the market are far too expensive for use in developing countries.

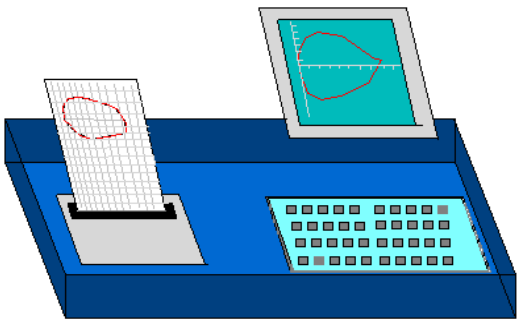

Figure 2 : Illustration of a commercially available Spirometer

There are various approaches to designing Spirometers viz. solid-state pressure sensor approach, volume based sensor approach, Convective heat

transfer, turbine based anemometer design & Air flow acoustics approach. The solid-state pressure sensor approach will be discussed extensively in the later sections. Volume based spirometers work on the principle of measurement of air volume through downward displacement of water. The merits of this approach are its simple design, low cost & a permanent mouth-piece design. The permanent mouthpiece also eliminates the need for a reliable supply of mouthpieces to use the device. This design would also be relatively simple to construct, and repairs would be very basic.

However, this device is quite large in size in comparison to the other designs. The chamber would have to expand to a volume of at least eight liters according to these design constraints, and the elongated tube would also add to the bulk of the device. Reliability is also an issue with this design as the tube contains a significant amount of dead space. This dead space not only weakens the signal, but could also increase the need for calibration.

Hot-wire based spirometers are based on the principle of Covective heat transfer. The rate of cooling is proportional to the rate of flow of fluid through the hot-wire sensor [10]. The value of *h* depends on the fluid mass flux (density * velocity) and dimension of sensor. The function between *h* and velocity can be experimentally determined by best fitting the parameters in modified King's law for free convection heat transfer at low Reynolds number (R_e) in a long cylindrical structure.

Resistance of hot-wire sensor: $$R_S = Ae^{\frac{B}{T_S}} \quad (1)$$

Power Delivered to Sensor: $$P = hS(T_S - T_f) \quad (2)$$

Where:

B = a material dependent constant;
T_S = temperature of the sensor in K;
R = resistance at temperature Ts
T_o = reference temperature in K
R = resistance at temperature T_o
T_f = Fluid temperature
h = heat transfer coefficient referred to the sensor surface in W/m^{2}K
S = surface are of the sensor.

$$h = C_o + C_1 v^n \quad (3)$$

The hot-wire sensor (Japanese CHEST M.I. INC., Hi- 501) is placed on one arm of Whetstone bridge and excited with constant voltage without negative feedback. The output signal is amplified and digitized by ADC of Lab-VIEW system or prototype system.

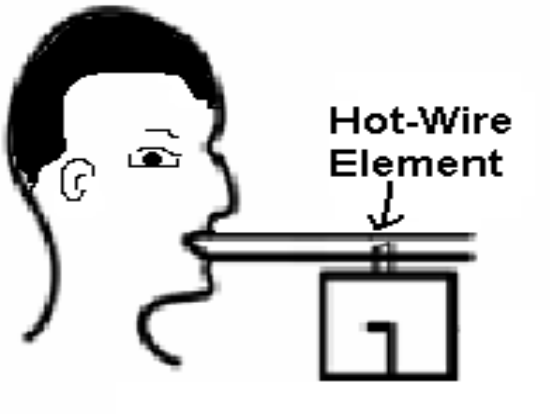

Figure 3 : Illustration of hot-wire based Spirometry technique

The air turbine based spirometers are based on the principle of direct proportionality of rotation speed on flow rate. Some of the demerits of this approach are friction related drag leading to inaccurate results at the fag ends of the respiratory cycle. Hence this leads to a non-linearity of rotation speed at the beginning and end of the breathing cycle.

II. Design of Pressure Sensor Based Spirometer System

a) Principles of Fluid Dynamics

Total Pressure of a fluid flowing through a tube is the sum of the static and dynamic components. Static component of pressure is essentially the pressure exerted on the walls of the tube when the fluid is at rest (velocity = 0 m/s) whereas the dynamic component gives the pressure exerted by fluid when in motion. The dynamic pressure is dimensionally referred to as the change in kinetic energy per unit volume. Our spirometer system is designed to work on the principle of measurement of dynamic pressure of a fluid when it traverses a tube.

Dynamic Pressure: $$P = \frac{1}{2}\rho v^2 \quad (4)$$

Where: ρ = Density of Air at 300° K
v = Velocity of flow of fluid

Once the dynamic pressure is extracted from the sensor, the Velocity of flow can be determined using equation 4.

Flow-rate: $$F = A \times Velocity \quad (5)$$

Where: A = Area of cross-section of tube

Total Volume of air can be determined by equation 6.

Volume of Air: $$V = \int_{t1}^{t2} F \cdot dt \quad (6)$$

The illustration in figure 4 shows the functional block diagram of the devised spirometer system. The first block is concentrated on the front-end of the system, in this case, the mouthpiece device. The second block is dedicated to the sensing device, in this case a FREESCALE Semiconductors Inc. dual port, MEMS based pressure sensor (MPXV2010DP). The third level is reserved for the analog signal conditioning function. The fourth and fifth modules contribute towards signal digitization and ultimate display of the output of the system.

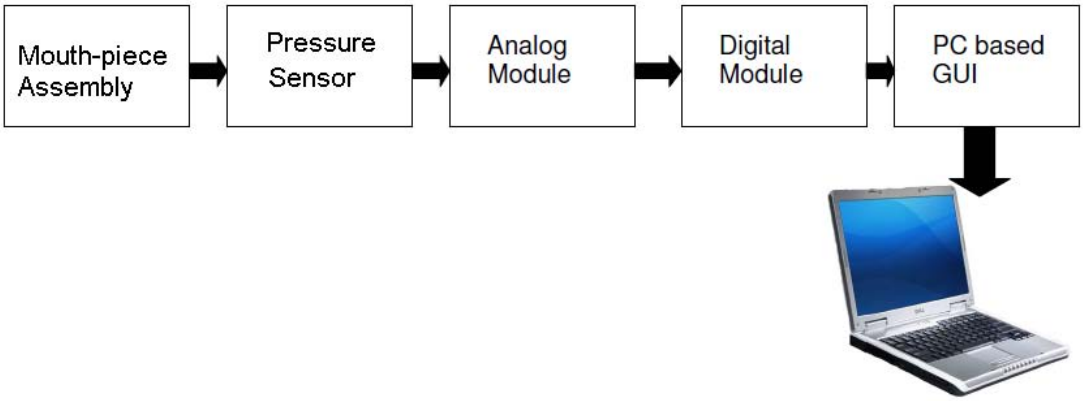

Figure 4 : Functional block diagram of the complete Spirometry System

b) Sensor Calibration

Prior to making any measurement, the pressure sensor needs to be calibrated for its performance. A FLUKE Inc. blood pressure simulator (BP-PUMP2) has been employed for applying a fixed quantum of static pressure on the sensor ports. The positive side port was calibrated first by connecting to the simulator. The applied pressure was varied from 6.7 kPa to 13.3 kPa and the voltage at the output of the analog circuit (described in section II c) was measured. This output voltage was normalized by subtracting the mid-point potential of 5V (Maximum input swing for ADC) with the output value. This results in a range of voltage values from 0 to 5 V with 2.5V as centre value. The pressure to voltage conversion factor (+ve & -ve ports) was also calculated from the formula given in Table-2. This factor was crucial in deducing the pressure value from the output of the ADC. Alternately, the applied pressure was calibrated using a sphygmomanometer in parallel with the fluke BP simulator and the deviation of pressure values was found to be 1.55% between the mercury readings and our system.

Table 2 : Calibration values for positive side port of sensor

Sr. No.	Pressure (applied) (kPa)	Output Voltage "V_P" (+ve Port) (Volts)	Normalized Voltage (V_P -2.5) (+ve Port) (Volts)	Pressure to Voltage conversion factor [Pressure / (V_P-2.5)] (kPa / Volts)	Average Conversion factor (kPa / Volts)
1	6.7	3.28	0.78	8.58974	8.3907
2	8	3.41	0.91	8.79121	
3	9.3	3.64	1.14	8.15789	
4	10.6	3.79	1.29	8.21705	
5	12	3.95	1.45	8.27586	
6	13.3	4.1	1.6	8.3125	

Table 3 : Calibration values for negative side port of sensor

Sr. No.	Pressure (applied) (kPa)	Output Voltage "V_N" (-ve Port) (Volts)	Normalized Voltage ($2.5-V_N$) (-ve Port) (Volts)	Pressure to Voltage conversion factor [Pressure / ($2.5-V_N$)] (kPa / Volts)	Average Conversion factor (kPa / Volts)
1	6.7	1.83	0.67	10.00	9.75734
2	8	1.68	0.82	9.7561	
3	9.3	1.54	0.96	9.6875	
4	10.6	1.40	1.1	9.63636	
5	12	1.27	1.23	9.7561	
6	13.3	1.13	1.37	9.70803	

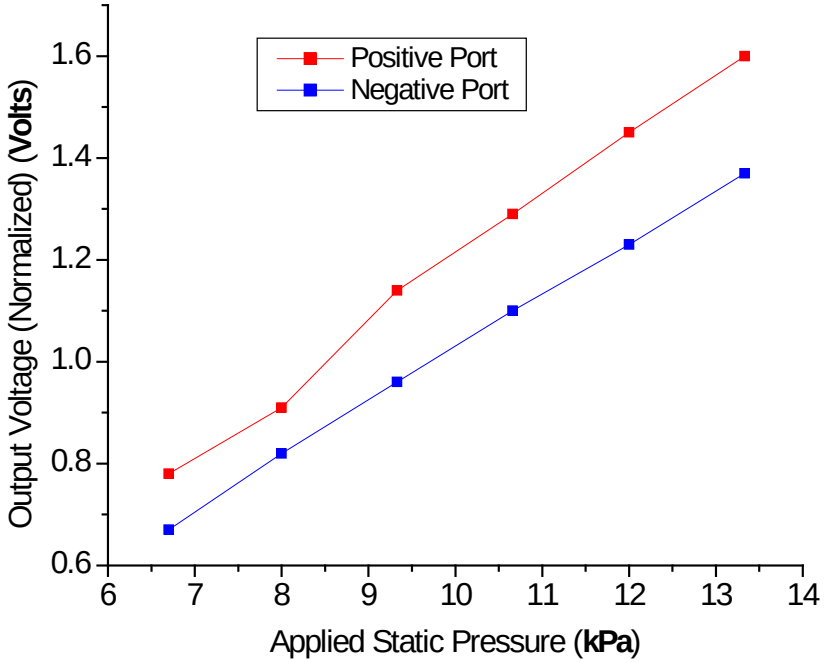

Fig. 5 : Normalized output voltage versus applied static pressure

c) Analog signal conditioning module

The analog circuit (Fig. 6-a) for the Spirometry system consists of instrumentation amplifier (AD624) in conjunction with an OPAMP. The output of the IA is then coupled as input to a general purpose OPAMP (AD713) for further amplification to give a signal large enough to drive the input to an ADC in the digital micro-controller module. Presently, the total gain of the system is 55. Gain can be tuned depending on the value of the output signal from the pressure sensor and the ADC input range. Additionally, level-shifting block is added at the output to prevent the negative drift of output voltage from the negative pressure port of the sensor. This level shifter is designed with a single low power, low leakage current Quad OPAMP (LMC 6044) in a summation configuration. The input reference voltage is fixed at the mid-gap of the ADC range of 5V. The reference voltage of 2.5V is supplied by a potential divider arrangement consisting of two 1MΩ resistors. The mid-point of the divider is connected to a buffer for voltage stability and the output of the buffer is connected to the non-inverting terminal of the level shifter OPAMP. A photographic illustration of the realization of the analog circuit over multipurpose PCB is shown in figure 6-b.

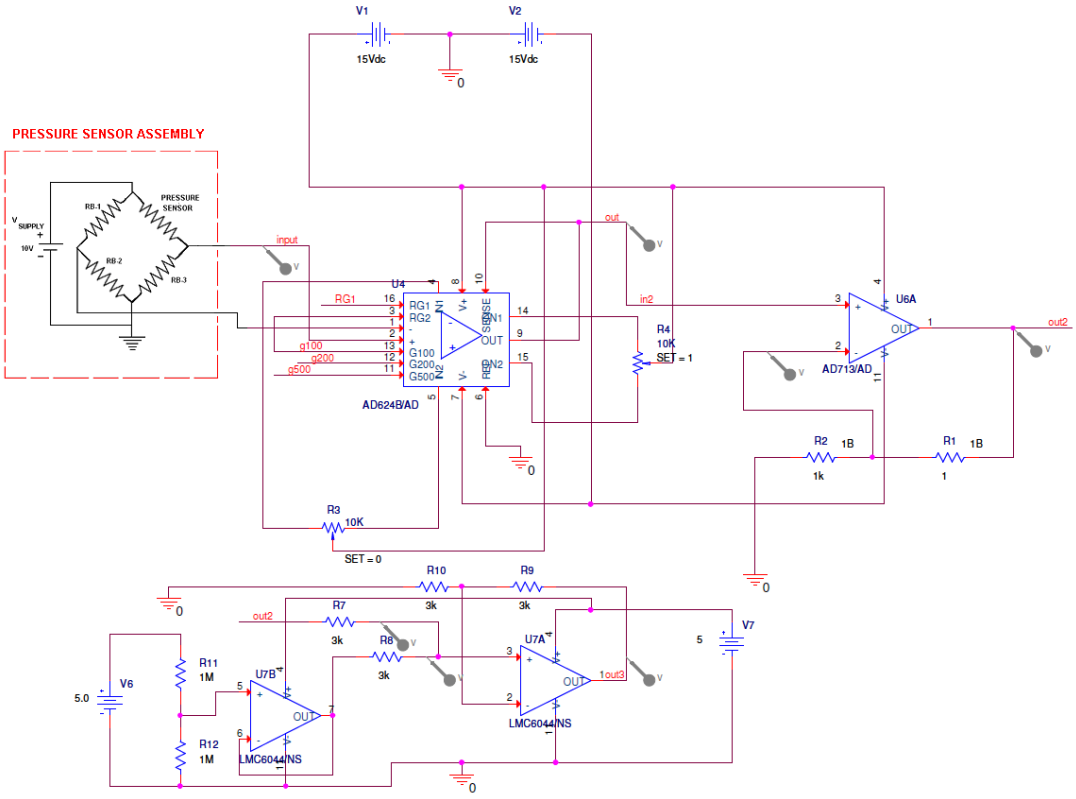

Fig. 6 (a) : Schematic diagram of the Analog signal conditional module

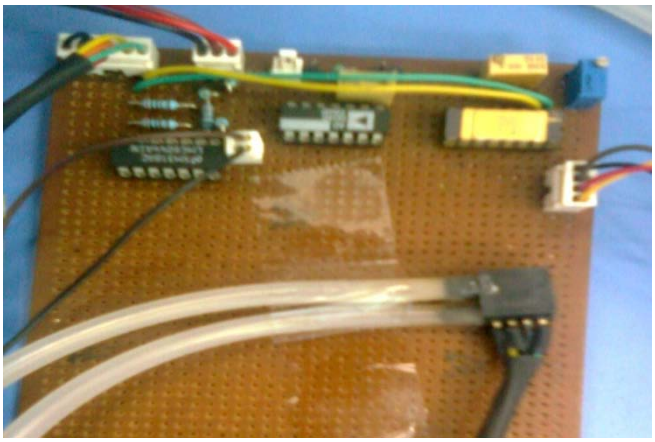

Fig. 6 (b) : Photograph of the realization of the analog circuit over multipurpose PCB

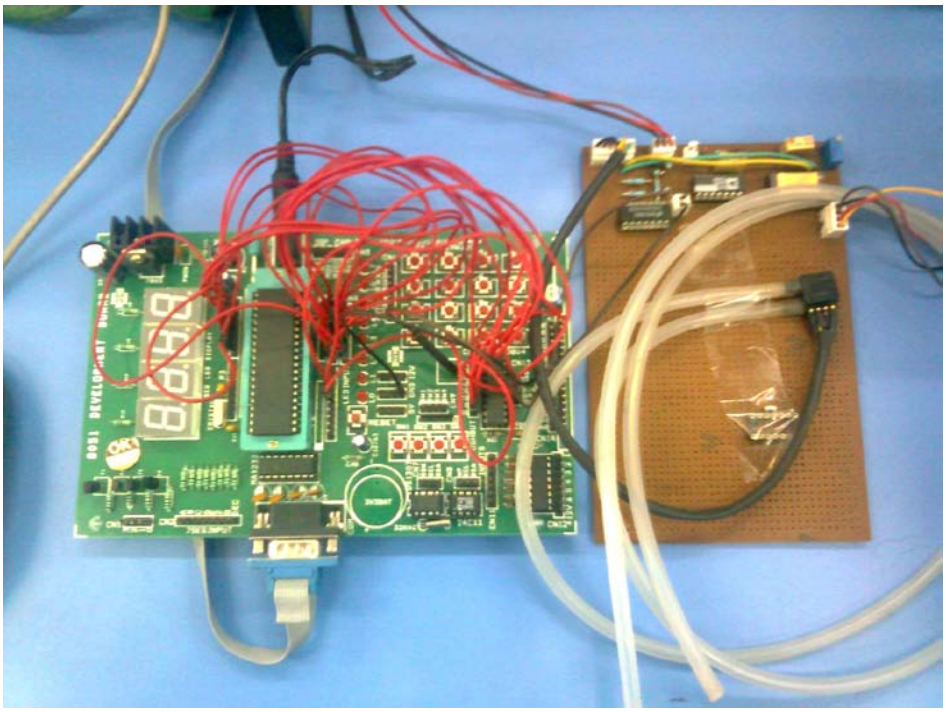

Figure 6 (c) : Photograph of the complete analog & digital setup

d) Design of micro-controller firmware

A digital module (Fig. 6-c) consisting of the analog to digital converter (ADC0804), RS-232 interface & microcontroller (89V51RD2) was employed to convert the analog signal to a digital output and send data in digital form to the computer via the RS-232 port. The sampling frequency of the ADC was set at 700 Hz for digitizing the input signal. Since the input signal is of very low frequency (<10Hz), a sampling frequency of 700Hz is enough to give good real time performance.

The flow of the implemented micro-controller firmware program has been illustrated in figure 7. To begin with, the read, write & interrupt pins of the ADC were assigned to P2^5 (Pin-5 of Port-2), P2^6 & P2^7 of the micro-controller. The next step was to initialize the counter and assign pin-0 of Port 3 to a variable called LED which would then be called after conversion is performed. The next block of the flow chart is dedicated for setting the buffer for transferring data to serial port. Then comes the block for setting parameters for beginning the conversion cycle for the ADC to Read/Write and transmit. The subsequent block for setting the timer interrupt for a sampling frequency of 700 Hz, calling the ADC from the timer interrupt ensuring a timer synchronized conversion & setting the output to toggle the port assigned to variable LED. The subsequent blocks are dedicated to setting the timer 1 in mode 2 for a baud rate of 9600 bps, enabling interrupt and starting timer.

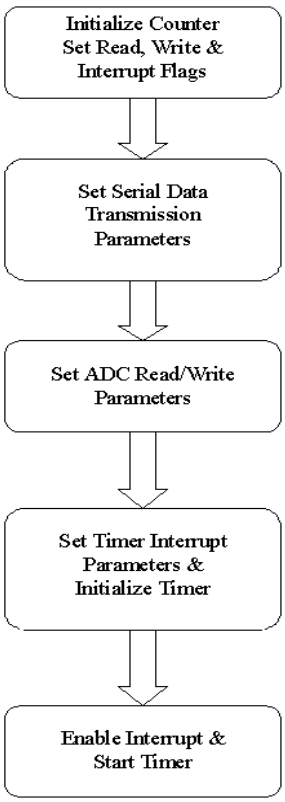

Figure 7 : Flow chart of the implemented micro-controller program

e) Design of Computer Software

The digital module sends data to the computer, which then had to be interpreted and plotted. For this purpose an interface program has been coded using the Lab-Windows software. Some of the salient features of the developed GUI software are as follows:

- Real-time acquisition and display of data
- Facility to print output panel in PDF format
- Ability to save plotted data in raw ASCII format
- Facility to enter patient name in panel
- Control of acquisition and display by use of Stop and Resume buttons
- Display of raw ADC data in Decimal format
- Display of ADC input voltage in real time graph & mean voltage in numeric format.
- Display of mean values of Pressure, Flow-rate (m^3/s & Litre/s), Volume, Full Vital Capacity (FVC), Forced Expiration Flow (FEF 100%), & Forced Expiration Volume (FEV).
- Real-time graphical output of Pressure v/s time, Flow-rate (Litre/s) v/s time, Flow-rate v/s Volume (Spirograph).

The spirometer system including the software has been tested with an indigenously designed proto-type mouthpiece. The system has been tested on a real human subject and results are discussed in the following section. Figure 8 shows a snapshot of the function panel of the designed software. The spirograph shows a value of volume, which is having a zero error of 2 litres, which meant that the actual total volume of air inhaled/exhaled is roughly 6 litres. The software also allows for entering calibrated zero-error values of pressure and voltage making it highly versatile. It also features a real-time display of digitized voltage for cross-checking of output data.

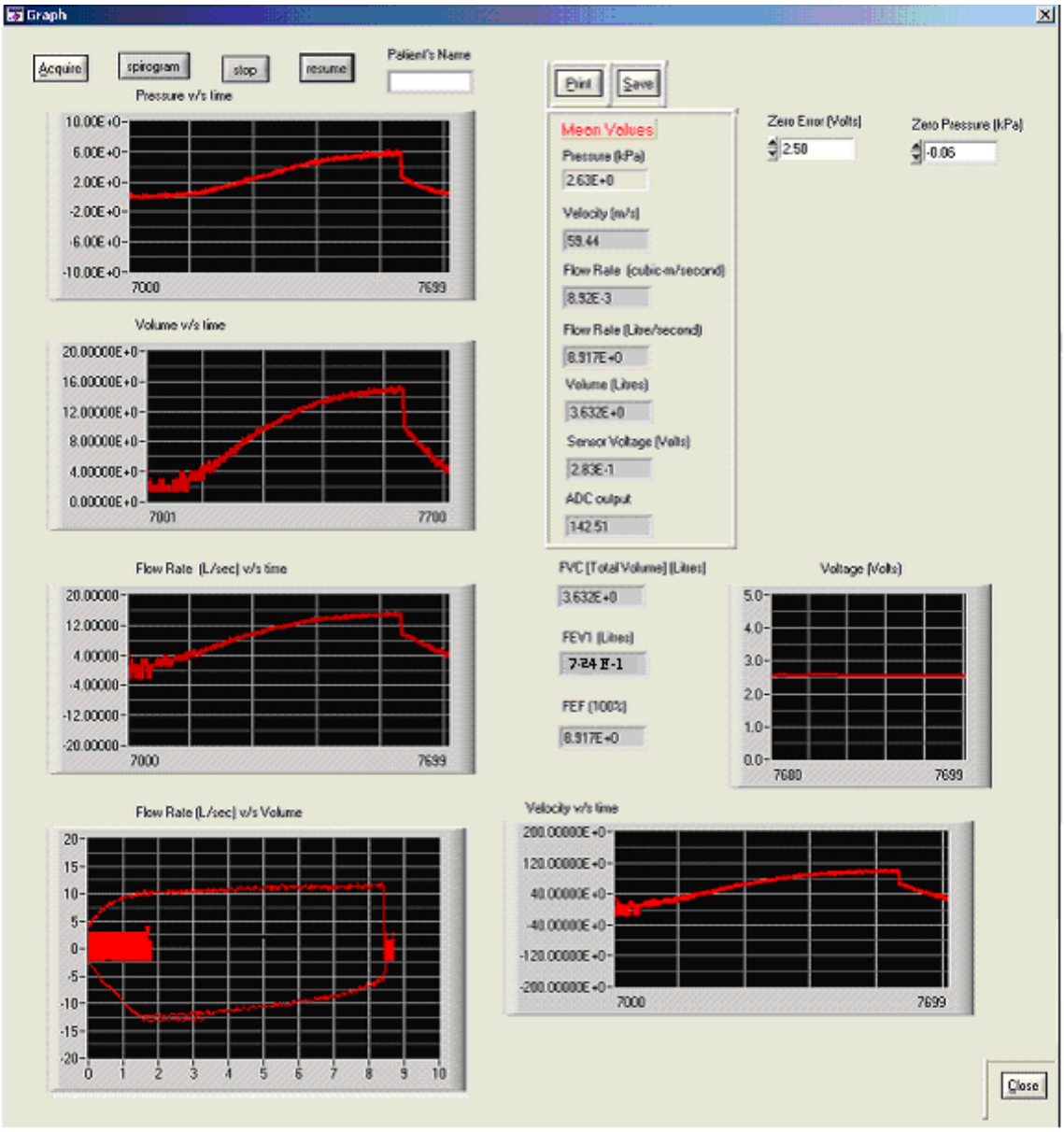

Figure 8 : Snapshot of the GUI program for the Spirometer System showing a sample Spirograph taken for a human subject

f) Design of Mouthpiece

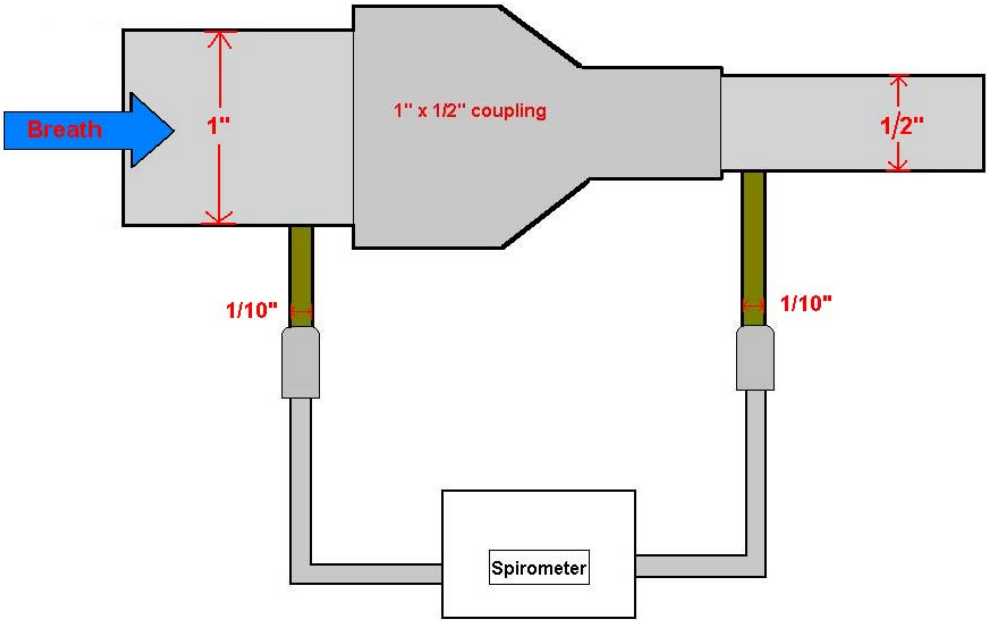

Figure 9 (a) : Illustration depicting the designed mouthpiece with dimensions

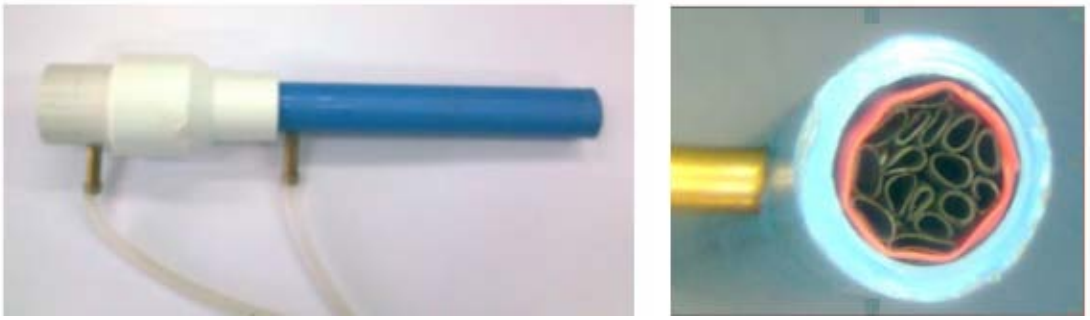

Figure 9 (b) : Photograph of the fabricated mouthpiece (left) and cross-section showing the laminar flow resistor (right)

The first proto-type of the spirometer mouthpiece has been designed and fabricated using in-house facilities. The mouthpiece has been designed for a 50% drop in pressure across its length. The design essentially consists of two PVC pipes connected via a coupling. The tube facing the patient was of 1 inch diameter which was connected to a 1" to 0.5" reduction coupling. The latter end of this coupling was connected to a 0.5" PVC pipe. The pressure sensing ports connecting the pressure sensor with the mouthpiece were fixed at either ends of the coupling assembly in a linear and coplanar fashion. There is a Fleisch type air resistance assembly that converts the turbulent flow input from the patient to laminar flow for better sensing accuracy (figure 9-b) and it is placed in the space between the sensing ports. The patient blows air from the left end (Fig. 9-a) resulting in a pressure difference between the ports which is in-turn sensed by the silicon pressure sensor and converted to meaningful output by the system.

III. Results & Discussions

The completely developed spirometer assembly together with mouthpiece, analog & digital modules, and software was tested with a human subject. The subject was instructed to follow the standard breathing maneuvers and the data was acquired for real-time calculation of spirometry parameters. The zero-error/tolerance values for various parameters are listed in table 4 below. The area of cross-section of the mouthpiece was 1.5 $x10^{-4}$ m^2. Mean values of air velocity, flow-rate & total volume were extracted for each respiratory cycle and tabulated in table 5. The measured volume was correlated with a standard calibration syringe. As seen from figure 10, the air velocity has a direct proportionality w.r.t the flow-rate. A respiratory cycle is such that the velocity and flow-rate are continuously varying functions of time. A time integration of the flow-rate will yield the cumulative volume in one respiratory cycle. The plot in figure 11

exhibits a near linear dependence of the displaced air volume on the flow-rate thereby confirming that the data is taken from a single person, as over a short duration of time, the physical status of the individual remains practically constant.

Table 4 : Tolerance values of various parameters

Parameter	Value
Pressure	0.06 kPa
Volume	0.8 Litres
Velocity	1 m/s
Flow-rate	0.15 L/s

Table 5 : Spirometric Test Results (mean values)

Sr. No.	Velocity m/s	Flow-rate Litre/s	Volume Litres
1	44	6.6	3.13
2	53.9	8.08	3.97
3	65.07	9.75	4.74
4	67.1	10.15	5.04
5	75.18	11.38	5.49
6	82.3	12.35	6.23
7	86.09	12.91	6.48

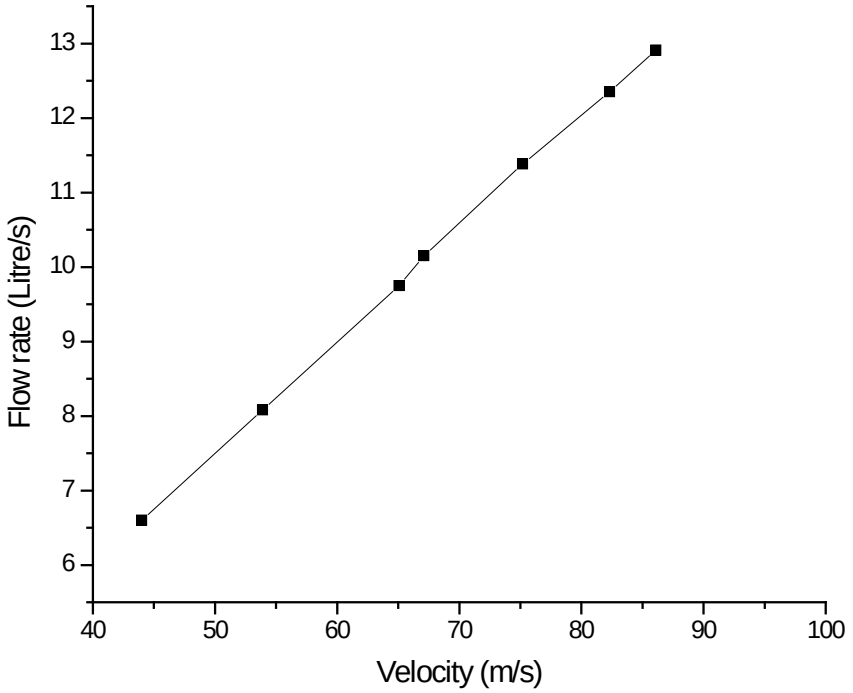

Figure 10 : Plot showing the Velocity versus Flow-rate proportionality

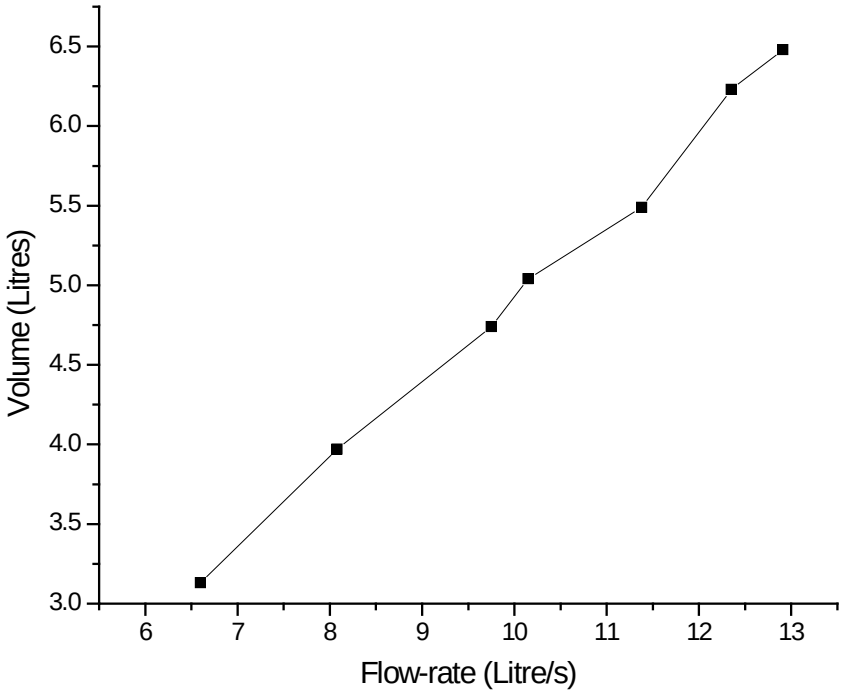

Figure 11 : Plot depicting Volume versus Flow-rate for a human subject over various respiratory cycles

IV. Conclusions

The solid-state sensor approach to realizing a spirometer system has been employed with good degree of success. The pressure sensor has been extensively characterized with calibrated amounts of static pressure and the pressure to voltage conversion factor has been empirically estimated. The analog circuit has been designed with great care to prevent any non-linearity in operation. Micro-controller firmware program has been designed with a view to minimize conversion losses and give real-time data at the output. The computer software has been developed with a view to display significant Spirometric data in real-time. This software has also been designed with a user-friendly approach in mind and gives a fair deal of control to the operator. An indigenous design of a proto-type mouthpiece has been able to achieve good results. Preliminary test results have indicated that the system has performed with a great degree of accuracy. Hence, the first principle's approach to realizing of a Spirometer using a solid-state pressure sensor has succeeded. Extensive trials need to be performed on human subjects to gather statistical data for further analysis.

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Establishment of Local Reference of Spleen Length in Sudanese Normal School age Children Sonographically

By Maha Nouri, Caroline Edward Ayad, Elsaffi Ahmed Balla & Samih Kajok

Sudan University of Science and Technology, Sudan

Abstract- *Objectives:* The objectives of this study were to establish a local ultrasonic splenic length which can be used as reference for Sudanese healthy school age children and to determine the normal standards spleen length related to gender, age, body weight, height, body mass index (BMI), and abdominal circumference.

Methods: 215 healthy school-aged children (7–13 years) from city centers were evaluated. Gender, age, weight, height, BMI, and abdominal circumference were determined for each case. The sonographic examination for spleen length was performed with a high resolution real time scanner (SSD-500 Aloka Medical System) fitted with a 3.5MHz convex transducer; all of the measured spleens had a normal position, shape, and echo texture. The children were classified into 7groups according to age and gender.

Results: The mean length of the spleen was found to be 9.5-10.4cm.There was significant difference between the spleen length in males and females (*P*-value 0.000), the mean length of spleen in females is greater than in males. A significant relation was found between spleen length and age, weight, height, abdomen circumference and BMI.

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Strictly as per the compliance and regulations of:

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Abstract- *Objectives:* The objectives of this study were to establish a local ultrasonic splenic length which can be used as reference for Sudanese healthy school age children and to determine the normal standards spleen length related to gender, age, body weight, height, body mass index (BMI), and abdominal circumference.

Methods: 215 healthy school-aged children (7–13 years) from city centers were evaluated. Gender, age, weight, height, BMI, and abdominal circumference were determined for each case. The sonographic examination for spleen length was performed with a high resolution real time scanner (SSD-500 Aloka Medical System) fitted with a 3.5MHz convex transducer; all of the measured spleens had a normal position, shape, and echo texture. The children were classified into 7groups according to age and gender.

Results: The mean length of the spleen was found to be 9.5-10.4cm.There was significant difference between the spleen length in males and females (*P*-value 0.000), the mean length of spleen in females is greater than in males. A significant relation was found between spleen length and age, weight, height, abdomen circumference and BMI .

Conclusion: The spleen length obtained in this study was in different range of values reported in previous studies and a local reference of spleen length was established. We hope that this study contributes to daily clinical practice in ultrasound clinics for interpretation of sonographic examinations for Sudanese school age children regarding the spleen length.

I. Introduction

The spleen is the largest organ in the reticulo endothelial system. Spleen size can be used as an indicator of disease activity in a variety of disorders of the reticulo endothelial system. [1]

The spleen responds to different pathologic states by dimensional changes. Malaria and sickle cell disease with a geographical bias are known to cause changes in spleen size. A rapid increase in spleen size, secondary to sequestration of red blood cells, platelets and other haematological elements, was observed in neonates on extracoporal membrane oxygenation [2, 3, 4]

There are several studies about normal internal organs character [5, 6] All of these are from the populations of Caucasoid and from the populations of Asian, Japan, China, Korea, and India. In the past, Thailand normally used references from American or European references. The problem is that the differences of these factors make the indicators different: race, body structure, genetic, environment, living condition, life style, and food. [7, 8].

Spleen size varies widely according to age also many diseases can affect its size, including infections and malignancy.. [9,10]

The variations in the anthropometric features of various populations, races and regions are an established fact. The climate of the zone and the socio-economic status of Sudan, make the population of this region special. There is no comprehensive anthro-pometric study on the normal measurements of spleen by ultrasonography in Sudanese, and therefore, it was thought to be important to undertake the present study to evaluate the normal measurements of spleen in the school age Sudanese population.

Radiography and radionuclide studies expose the patient to X and gamma radiation [10,11,12,13]. Ultrasonography is the method of choice for the diagnosis of the abdominal pathologies [14]. Sono-graphy is routinely used to determine the internal structures of the body because the examination is real time, three-dimensional and independent of organ function .Ultrasonography is a non-invasive, established, safe, quick and accurate method for the measurement of spleen size. [13]

In Sudan, There is absence of domestic reference for spleen length; and as far as we know, no study was published in the open literature, regarding the spleen length for school age children therefore, the importance of this study lies in finding the normal length of spleen and to determine its correlation with gender, age, height, weight, body mass index (BMI) and abdominal circumference.

II. Materials and Methods

The study was done in Alsidigah School and Hamza Ebn Abdmutalib School in Bhari city from January 2012-February 2012.

Authors α σ ρ ω : Sudan University of Science and Technology College of Medical Radiological Science. E-mail : Carolineayad@yahoo.com

a) *Ultrasound Machine*

The sonographic examination performed with a high resolution real time scanner (SSD-500 Aloka Medical System Co, Ltd, Tokyo, Japan) with a 3.5MHz convex transducer.

b) *Sample*

A total of 215 (104 males, 111 females) healthy Sudanese children with normal spleen position, shape and echo texture. Any abnormal spleen position, shape and echo texture, children affected with malaria, malignant spleen diseases, benign spleen conditions, traumatic spleen were excluded.

c) *Measurement Technique for spleen*

Spleen Length was taken by measuring the longest dimension in coronal plane. Longitudinal dimensions in the coronal plane were obtained with the subject in supine or slightly right lateral decubitus position; longitudinal size measurement was performed between the most supero medial and the most infero lateral points of the spleen.

III. Results

Table 1 : Spleen length measurement classes, frequency and percentage

Spleen	Frequency	Percentage
6.5-7.4	28	13.0%
7.5-8.4	43	20.0%
8.5-9.4	56	26.0%
9.5-10.4	67	31.2%
≥ 10.5	21	9.8%
Total	215	100.0%

Table 2 : Descriptive statistics for subject's physical data and spleen length measurement

	BMI	Weight (Kg)	Abdominal circumference	Height (M)	Spleen (cm)
Mean	16.8	32.5	58.2	137.9	9.0
Std. Deviation	±3.4	±10.1	±7.1	±11.0	±1.2
Minimum	10.4	16.0	43.0	112.0	6.7
Maximum	33.6	71.0	83.0	167.0	11.7

Table 3 : mean values of the variables according to age

Variable	Age							Total	*P*-Value
	7	8	9	10	11	12	13		
BMI	14.4 ± 2.0	14.7 ± 2.2	18.0 ± 4.5	17.0 ± 2.8	16.7 ± 2.7	18.1 ± 2.9	18.9 ± 3.6	16.8 ± 3.4	0.000*
Weight	22.9 ± 3.6	24.1 ± 4.8	32.9 ± 9.3	33.1 ± 7.5	33.5 ± 6.0	38.8 ± 7.7	44.5 ± 10.2	32.5 ± 10.1	0.000*
Abdominal circumference	53.9 ± 4.1	53.5 ± 5.2	60.2 ± 8.5	59.3 ± 6.4	58.8 ± 5.3	59.1 ± 6.8	63.8 ± 7.1	58.2 ± 7.1	0.000*
Height	126.1 ± 5.5	127.6 ± 5.4	134.7 ± 4.3	139.0 ± 7.4	141.4 ± 5.1	146.0 ± 6.5	152.8 ± 8.9	137.9 ± 11.0	0.000*
Spleen	7.9 ± 0.7	7.7 ± 0.6	8.9 ± 1.3	9.3 ± 0.8	9.4 ± 0.6	9.9 ± 0.7	10.1 ± 0.7	9.0 ± 1.2	0.000*

Table 4 : mean values of the variables according to gender

Variable	Gender		Total	P-Value
	Male	Female		
BMI	16.6 ± 2.3	16.9 ± 4.2	16.8 ± 3.4	0.580
Weight	31.6 ± 7.8	33.4 ± 11.8	32.5 ± 10.1	0.195
Abdominal circumference	57.2 ± 5.6	59.3 ± 8.1	58.2 ± 7.1	0.029*
Height	136.9 ± 10.5	138.8 ± 11.4	137.9 ± 11.0	0.203
Spleen	8.7 ± 1.1	9.3 ± 1.1	9.0 ± 1.2	0.000*

From above table we have significant difference between males and females in (Spleen and Abdomen circumference) P-value was less than 0.05, that means the mean length of Spleen and Abdomen circumference) in females was more than mean length of Spleen & Abdominal circumference) in males, respectively.

Table 5 : mean values of the variables according to age & gender

Age	Gender	BMI*	Weight	Abdomen circumference	Height	Spleen
7	Male	15.6 ± 1.8	23.7 ± 3.4	53.5 ± 4.1	123.7 ± 6.9	8.0 ± 0.8
	Female	13.6 ± 1.7	22.3 ± 3.7	54.3 ± 4.2	127.9 ± 3.5	7.9 ± 0.5
8	Male	15.7 ± 1.6	26.0 ± 3.7	54.3 ± 3.1	128.4 ± 5.7	7.5 ± 0.6
	Female	13.7 ± 2.3	22.1 ± 5.2	52.7 ± 6.8	126.8 ± 5.1	7.8 ± 0.5
9	Male	16.5 ± 1.6	29.5 ± 3.9	57.1 ± 4.9	133.7 ± 4.5	7.9 ± 0.7
	Female	19.6 ± 5.9	36.3 ± 11.8	63.3 ± 10.3	135.7 ± 4.1	9.9 ± 0.9
10	Male	16.7 ± 2.2	31.9 ± 4.3	58.7 ± 4.3	138.1 ± 5.8	8.6 ± 0.4
	Female	17.3 ± 3.3	34.2 ± 9.7	59.9 ± 8.1	140.0 ± 8.9	10.0 ± 0.3
11	Male	16.1 ± 2.2	32.3 ± 5.5	57.3 ± 4.5	141.3 ± 5.8	9.2 ± 0.7
	Female	17.3 ± 3.0	34.7 ± 6.4	60.4 ± 5.7	141.5 ± 4.6	9.5 ± 0.3
12	Male	18.3 ± 3.2	37.8 ± 8.3	57.8 ± 6.8	143.2 ± 4.4	9.7 ± 1.0
	Female	18.0 ± 2.7	39.8 ± 7.2	60.3 ± 6.8	148.6 ± 7.2	10.0 ± 0.3
13	Male	17.7 ± 2.4	40.3 ± 8.5	61.5 ± 7.0	150.3 ± 9.7	9.8 ± 0.7
	Female	20.2 ± 4.3	48.6 ± 10.3	66.1 ± 6.6	155.3 ± 7.5	10.5 ± 0.5

*Values are expressed as Mean ± SD. *Body Mass Index (BMI)*

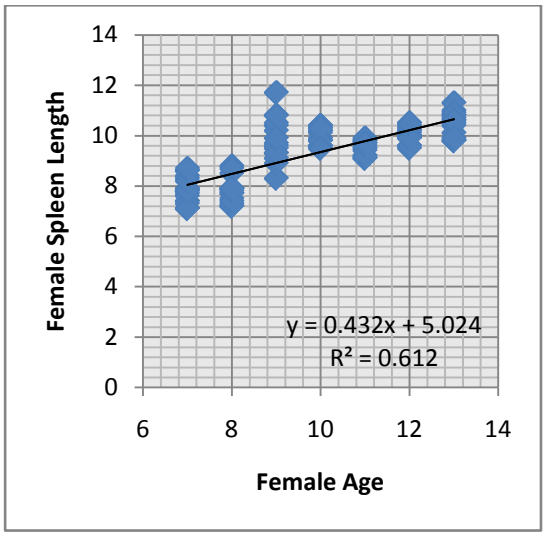
Table 6 : Proximity Matrix of correlation between variables

	Correlations	BMI	Spleen	Weight	Abdomen circumference
BMI	Pearson Correlation	1.00	0.54	0.88	0.84
	P-value	.	0.000	0.000	0.000
Spleen	Pearson Correlation	0.54	1.00	0.71	0.55
	P-value	0.000	.	0.000	0.000
Weight	Pearson Correlation	0.88	0.71	1.00	0.85
	P-value	0.000	0.000	.	0.000
Abdomen circumference	Pearson Correlation	0.84	0.55	0.85	1.00
	P-value	0.000	0.000	0.000	.
Height	Pearson Correlation	0.43	0.72	0.79	0.56
	P-value	0.000	0.000	0.000	0.000

From above table (6) it was noticed that all p-values are less than 0.05 that means that there is relationship between the variables. The Pearson Correlation denotes values of the correlation either positive (+) or negative (-) as follows:

- *0.90 – 1.00 very strong relationship.*
- *0.70 – 0.89 strong relationship.*
- *0.50 – 0.69 middle relationship.*
- *0.00 – 0.49 weak relationship*

[A]



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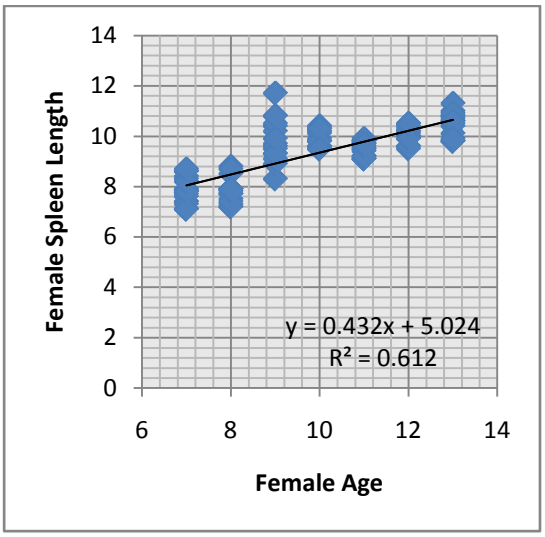
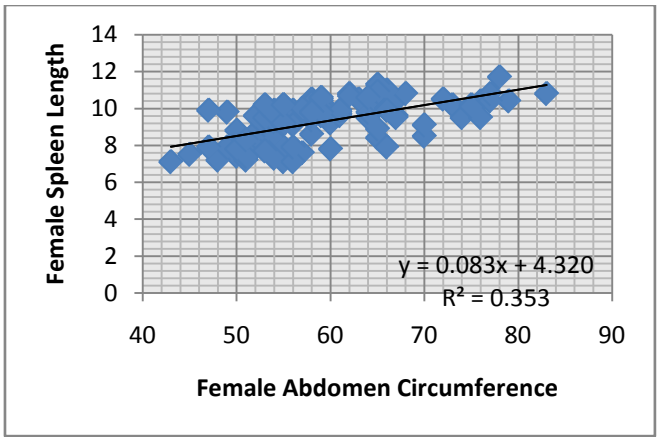
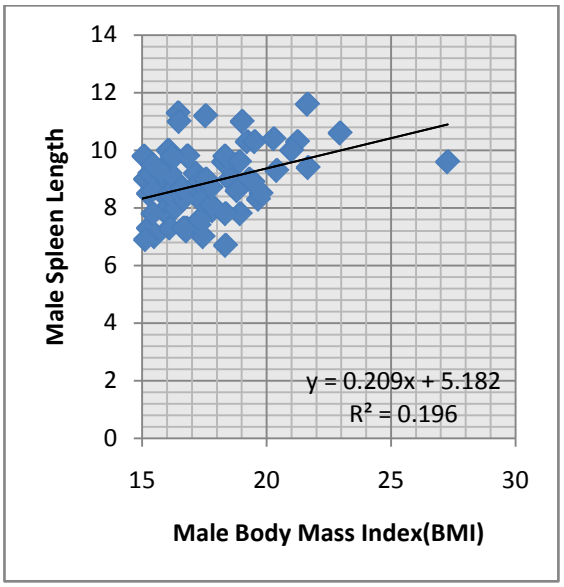




[C]

Figure 1 : [A,B,C]Scatter plot diagram shows the linear relationship between spleen length measured in (cm)and female BMI, age and abdomen circumference respectively



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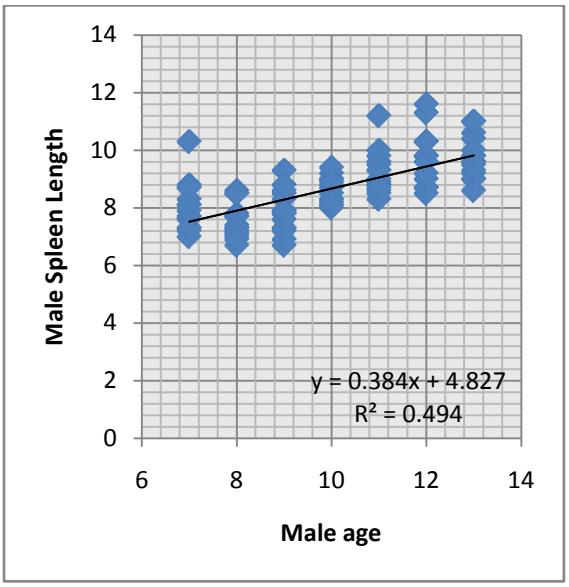

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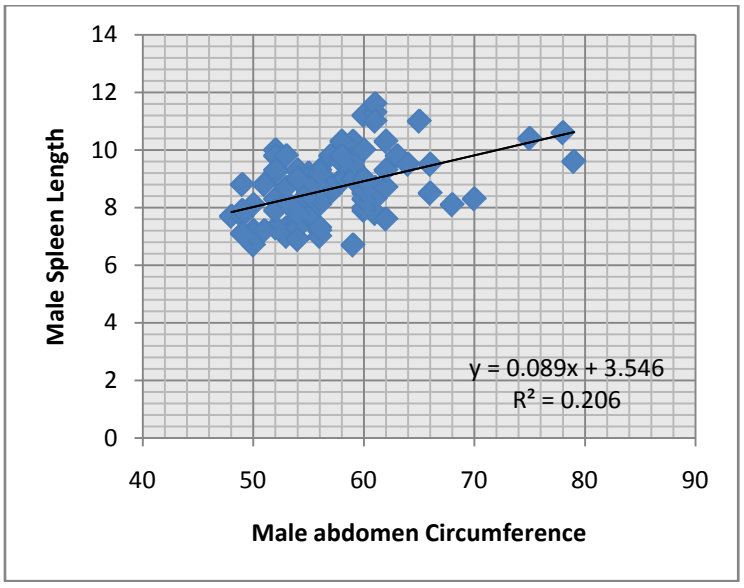

[C]

Figure 2 : [A,B,C] Scatter plot diagram shows the linear relationship between spleen length measured in (cm)and Male BMI, age and abdomen circumference respectively

IV. Discussion

Ultrasound is simple and reliable in measuring the abdominal visceral organs without the risk of ionizing radiation. Measuring the volume is time-consuming and impractical in daily use and the longitudinal measuring of these organs is used as part of routine abdominal sonographic scanning for purposes of determining the normal anatomy [15]. Therefore, the longitudinal measurement was used because it is more practically considered.

The length of the spleen is an adequate indicator of size for most purposes and provides a useful baseline for monitoring changes in disease status. Establishing normal parameters is mandatory for defining the pathologic changes in size of the spleen, in routine sonographic examinations of children.[15]

This study included 104(48.4%) males, 111(51.6%) females of school children with ages from 7 up to 13.When measuring the spleen;28 out of 215 (13.0%)got spleen length of 6.5-7.7 cm,43(20%)of 5-8.4cm, 56(26%) of 8.5-9.4cm,67(31.2%)of 9.5-10.4 and measurements greater than 10.5 were found in 21(9.8) of the sample, The mean spleen measurement was found to be 9.0 ±1.2 (max11.7, min6.7),normal spleen has been investigated by only a few researchers [16].When comparing our results with other similar results ,we found that Sudanese children have less length than USA in all group of ages but greater than Greek [16], Indian [17] and Turkish populations [18]

When comparing the spleen length measurement with age in all group of ages it was found to be 7.9,7.7,8.9,9.3,9.4,9.9,10.1,9.0 cm for the ages 7,8,9,10,11,12,13 respectively and the relation is significant between the spleen length and this group of children ages at *p* value 0.000.

DeLand [19] stated that the spleen showed variation according to sex and age. He reported that spleen in females was smaller than males in all age groups. But Niederau et al.[20] in their sonographic study, which was carried out on adults, found that spleen size decreased with increasing age.

In our study a significant difference was detected between males and females in spleen length and abdomen circumference measurements because *P*-value was found to be less than 0.05, that means the mean measurements values of spleen and abdomen circumference in females are greater than males and were found to be 9.3 ± 1.1 and 59.3 ± 8.1, 8.7 ± 1.1and 57.2 ± 5.6 respectively .

The study showed that the BMI, height, weight abdominal circumference have significant relation with the spleen length in all these group of ages.

From table (6) we noticed that all *p*-values are less than 0.05, that means there is a relationship between the variables. The Pearson Correlation denotes value of the correlation either positive (+) or negative (-) as follows: 0.90 – 1.00 very strong relationship, 0.70 – 0.89 strong relationship, 0.50 – 0.69 middle relationship, 0.00 – 0.49 weak relationship.

Scatter plot diagrams showed the linear relationship between spleen length measured in (cm) and females and males, BMI, abdomen circumference (AC) and age respectively. The equations showed that the for BMI and AC ,the spleen length was increased proportionally and by applying the following equations the spleen length can be estimated for these group of ages and known BMI and AC as :

For female Spleen length (cm) =(0.432 X Age) + 5.024 . For male Spleen length (cm) =(0.384 X Age) + 4.827. For female Spleen length (cm) =(0.172 X BMI) + 6.368,For male Spleen length (cm) =(0.209X BMI) + 5.182,For female Spleen length (cm) =(0.083 X AC) + 4.320,For male Spleen length (cm) =(0.089X AC) + 3.546.

In conclusion, the spleen length obtained in this study was in different range of values reported in the previous studies. The mean spleen length in females is greater than males .

By applying the above equations the spleen length can be estimated. A local reference of spleen length was established; further studies are required to establish national reference of spleen length and volume in Sudan for both children and adults.

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You can use your own standard format also.
Author Guidelines:

1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

1. GENERAL

Before submitting your research paper, one is advised to go through the details as mentioned in following heads. It will be beneficial, while peer reviewer justify your paper for publication.

Scope

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All authors should have been credited according to their appropriate contribution in research activity and preparing paper. Contributors who do not match the criteria as authors may be mentioned under Acknowledgement.

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3. SUBMISSION OF MANUSCRIPTS

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Complete support for both authors and co-author is provided.

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Based on potential and nature, the manuscript can be categorized under the following heads:

Original research paper: Such papers are reports of high-level significant original research work.

Review papers: These are concise, significant but helpful and decisive topics for young researchers.

Research articles: These are handled with small investigation and applications

Research letters: The letters are small and concise comments on previously published matters.

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The recommended size of original research paper is less than seven thousand words, review papers fewer than seven thousands words also.Preparation of research paper or how to write research paper, are major hurdle, while writing manuscript. The research articles and research letters should be fewer than three thousand words, the structure original research paper; sometime review paper should be as follows:

Papers: These are reports of significant research (typically less than 7000 words equivalent, including tables, figures, references), and comprise:

(a)Title should be relevant and commensurate with the theme of the paper.

(b) A brief Summary, "Abstract" (less than 150 words) containing the major results and conclusions.

(c) Up to ten keywords, that precisely identifies the paper's subject, purpose, and focus.

(d) An Introduction, giving necessary background excluding subheadings; objectives must be clearly declared.

(e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition; sources of information must be given and numerical methods must be specified by reference, unless non-standard.

(f) Results should be presented concisely, by well-designed tables and/or figures; the same data may not be used in both; suitable statistical data should be given. All data must be obtained with attention to numerical detail in the planning stage. As reproduced design has been recognized to be important to experiments for a considerable time, the Editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned un-refereed;

(g) Discussion should cover the implications and consequences, not just recapitulating the results; conclusions should be summarizing.

(h) Brief Acknowledgements.

(i) References in the proper form.

Authors should very cautiously consider the preparation of papers to ensure that they communicate efficiently. Papers are much more likely to be accepted, if they are cautiously designed and laid out, contain few or no errors, are summarizing, and be conventional to the approach and instructions. They will in addition, be published with much less delays than those that require much technical and editorial correction.

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It is vital, that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

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Abbreviations supposed to be used carefully. The abbreviated name or expression is supposed to be cited in full at first usage, followed by the conventional abbreviation in parentheses.

Metric SI units are supposed to generally be used excluding where they conflict with current practice or are confusing. For illustration, 1.4 l rather than 1.4 × 10-3 m3, or 4 mm somewhat than 4 × 10-3 m. Chemical formula and solutions must identify the form used, e.g. anhydrous or hydrated, and the concentration must be in clearly defined units. Common species names should be followed by underlines at the first mention. For following use the generic name should be constricted to a single letter, if it is clear.

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Abstract, used in Original Papers and Reviews:

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A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy and planning a list of possible keywords and phrases to try.

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

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TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

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20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

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24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

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33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

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Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

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- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

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Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

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The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

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- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

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This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

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- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
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
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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