Computerized Determination Of Velocity Time Integral In Normal Subjects.

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الخلاصة
المقدمة: إن تكامل المساحة لموجة جريان الدم يمكن اشتقاقه من تحليل صورة موجة الدوبلر ويمكن استعماله في إيجاد معلومات ديناميكية تخص أمراض قلبية معينة .
الهدف من الدراسة: إنجاز نافذة باستخدام برنامج البيسك المرئي لتحليل موجة الدوبلر لإيجاد تكامل المساحة تحت موجة الدوبلر عند الأشخاص الطبيعيين.
الطريقة: تم تحليل صور موجة الدوبلر لعشرين شخص طبيعي باستخدام برنامج حاسوبي مناسب و نافذة البيسك المرئي لإيجاد تكامل المساحة تحت موجة الدوبلر عند الأشخاص الطبيعيين .
النتائج: العوامل التي تم الحصول عليها من تحليل موجة الدوبلر هي زمن الضخ (ET) و معدل سرعة الدم خلال الصمام الأبهر (Vm), وقد استخدمت هذه العوامل لإيجاد (المعدل, الانحراف المعياري والخطأ القياسي) لتكامل المساحة تحت موجة الدوبلر (VTI) للأشخاص الطبيعيين في هذه الدراسة.
الاستنتاجات: تم إيجاد تكامل المساحة تحت موجة الدوبلر للأشخاص الطبيعيين من تحليل موجة الدوبلر الخاصة بهم باستخدام برنامج حاسوبي لنافذة البيسك المرئي حيث يمكن استخدام هذه الطريقة في تشخيص ومتابعة حالات معينة من الأمراض القلبية.

Abstract

Background: Velocity time integral (VTI) of the blood flow wave is derived from the analysis of the image of the Doppler wave. VTI can be utilized to determine hemodynamic information in certain cardiac disorders.
Objective: To establish visual basic form for analysis of Doppler wave to determine velocity time integral (VTI) in normal subjects.
Method: Doppler waves in twenty normal subjects were analyzed to determine VTI utilizing suitable computer program and visual basic form.
Results: The parameters obtained from the analysis of Doppler wave (Ejection time (ET) and Mean blood velocity across aortic valve (Vm)) were utilized to determine VTI of the normal subjects studied as Mean, ±SD, ±SDE.
Conclusion: The (VTI) was determined in normal subjects from their Doppler waves using a computer program of visual basic form that can be useful in diagnosing and following certain cardiac disorders.

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Introduction

In the main Doppler modalities (continuous and pulsed Doppler), the velocity information is derived from the frequency shift that occurs between transmitted and reflected ultrasound. By convention, a velocity towards the transducer is displayed above the base line of Doppler wave, and away from it bellows the base line. To record a Doppler spectrum across aortic valve, the sample volume is positioned in the aorta directly behind the valve [1].

VTI is the integral of the spectral trace or the area under the Doppler waveform (it can be determined by planimetric analysis) [1, 2].

VTI is utilized in the calculation of stroke volume, assessment of aortic valve diseases (aortic valve stenosis and regurgitation) [3,4,5], and in the predict of cardiac output [6].

In the present study new visual basic form was established using suitable computer programe for the analysis of the images of the aortic Doppler waves to determine VTI .

Materials and Methods

Twenty Doppler waves were analyzed to determine the derived Doppler parameters in twenty normal subjects who underwent echocardiography and Doppler study (across aortic valve in the apical five chamber view), their average values of some physical parameters and left ventricular dimensions at end systole and end diastole (LVESD and LVEDD) are shown in Table (1) and Table(2).

Table -1: Some physical parameters of the subjects studied.

Parameters	Mean	± SD	± SDE
Age (year)	29.1	9.89	2.21
HT (cm)	168.7	9.39	2.10
WT (kg)	72.75	12.71	2.84
HR (beat/min)	82.05	10.89	2.44

Table -2: LV dimensions at ES and ED with %EF of the subjects studied.

Parameters	Mean	± SD	± SDE
LVESD (cm)	3.34	0.32	0.07
LVEDD (cm)	5.10	0.32	0.07
%EF	71.82	4.57	1.02

The analysis of the Doppler wave is done according to the following steps:

1. **Establishment of visual basic form to analyze the Doppler waves in apical five-chamber view of the subjects studied (Fig.1), to determine the derived Doppler parameters (ET, Vm) of the blood flow across aortic valve of the patients studied.**

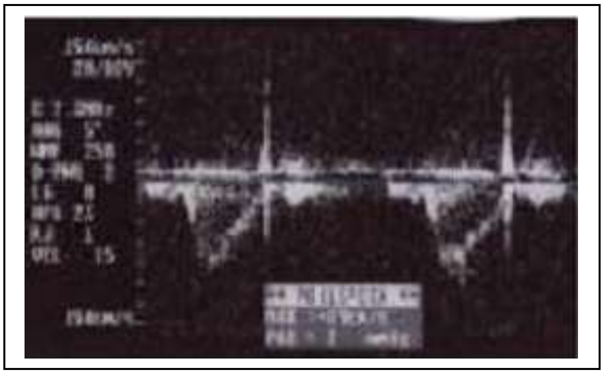

Figure- 1: The image of the Doppler wave of the blood flow across aortic valve in apical five-chamber view.

Computerized determination of the area (in cm²) within the curve of the Doppler wave (Ad), Vm (in cm/sec) , ejection time distance (ETd = the distance in cm between the crossing points of the basal line and the Doppler wave), and ET (in sec) to compute VTI (in cm) as demonstrated in flow chart one (Fig. 2).VTI is the integral of the spectral trace of all velocities during ET and equal to the actual area under the image of the Doppler signal [2].

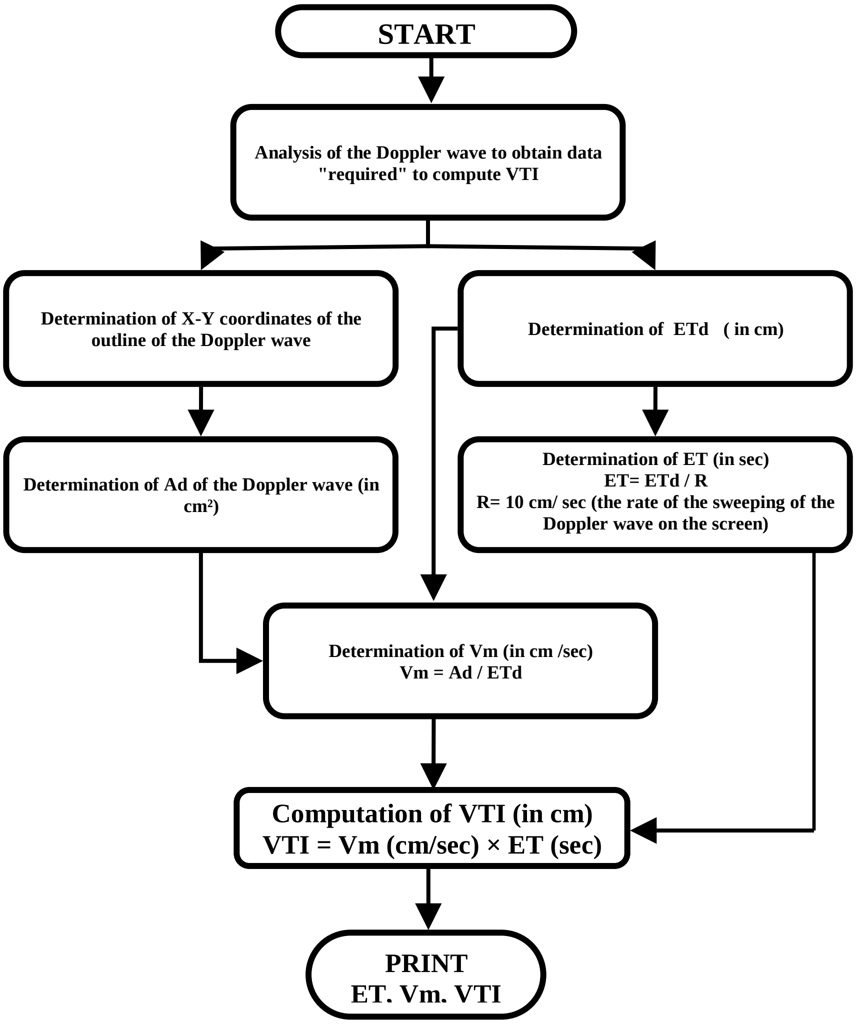

Figure- 2 : Flow chart one of the visual basic program used in the present study to compute VTI .

Results

All subjects studied fulfilled the criteria of normal LV dimensions and %EF in the present study (table 2). The readings of LV dimensions are within normal ranges (LVESD =3.34 ± 0.32 cm and LVEDD = 5.1 ± 0.32 cm) [7]. Also, (%EF =71.82 ± 4.57) are more than 55% [8] .

The results obtained from the analysis of the Doppler waves of the normal subjects studied (ET = 0.27 ± 0.04 sec, Vm = 68.05 ± 16.22 cm/sec, and VTI = 18.54 ± 4.4 cm), are listed in Table (3) as mean, ± SD and ± SDE.

Table -3 : Doppler –derived parameters of the subjects studied.

Parameters	Mean	± SD	± SDE
ET (sec)	0.27	0.04	0.01
Vm (cm/sec)	68.05	16.22	3.63
VT (cm)	18.54	4.40	0.98

Discussion

VTI is utilized in the determination of cardiac output and stroke volume [6]. Cardiac output has been measured from the pulmonary artery [9,10] and left outflow tract [11] with the use VTI obtained by pulsed – wave Doppler and continuos – wave Doppler [12]. Doppler stroke volume determination is based on the principle (stroke volume equal to VTI multiplied by the cross-sectional area of the aortic valve) [2].

Generally Doppler echocardiography provides accurate hemodynamic information for the diagnosis, assessment of severity and follow –up of patients with aortic stenosis and aortic regurgitation [3,13]. Also Doppler echocardiography may provide a reliable noninvasive method to determine pulmonary vascular resistance depending on the peak tricuspid regurgitant velocity and VTI of the right ventricular outflow tract [14].

In the present studies VTI is determined (computerized calculations) using personal computer and visual basic form. The method used is better than manual calculations using planimeter (which is time consuming). Also the present study can be applied to analyze the images of the Doppler waves of the patients that were previously studied (off-line method), while the Doppler wave analysis is on-line using the new echocardiography system.

VTI determined of the normal subjects studied in the present study is (18.54 ± 4.4 cm for the aorta), which is comparable with the VTI that previously determined by another investigators (18 to 20 cm for the aorta) [15, 16].

In conclusion the clinical application of the present method is to determine VTI of the Doppler waves of the blood velocity across aortic valve, which can be used as reference in the evaluation of the blood flow across aortic valve. VTI is a convenient guide to determine the severity of aortic valve diseases, stroke volume, cardiac output and vascular resistance in certain cardiac disorders.

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