VENTRICULAR TDI PARAMETERS ON THE SHORT AND LONG AXIS IN NORMAL ADULTS

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Abstract:
Background: Myocardial tissue Doppler helps to assess heart function and does not depend on preload, which overcomes the weakness of the conventional Doppler. The aim of this study is to provide normal myocardial tissue Doppler data in Vietnamese adults. **Subjects and method**: 126 normal persons, mean age 39.03 ± 11.55 (50.8% females , 49.2% male). Pulsed tissue Doppler has been used to take the velocity of: (1) The anterior and inferior wall of the left ventricle from mitral annulus to apex on the apical 2 chamber view. (2) The 6 segments of the left ventricle on the short axis of parasternal view at papilary level. **Results and conclusions:** TDI velocity decreased from valvular annulus to the apex. Am velocity inscreased with age when the Em velocity decreased. The Sm velocity was less affected by age. Gender may not influence the myocardial TDI velocity. It was difficult to measure the left ventricular TDI waves of the anterior wall on the short axis.

1. BACKGROUND

Tissue Doppler Imaging (TDI) is a technological advancement of echocardiography. TDI is a recently introduced echocardiographic tool for measuring myocardial velocities in systolic and diastolic periods - the informations concerning the ventricular functions. The TDI of mitral annulus is a good tool to assess the diastolic function of left ventricle, and it is not affected by preload and afterload. [2], [3].

In Viet nam, we have not yet, however, the detailed TDI parameters of the ventricular wall in normal Vietnamese adults. The aims of this study were *to provide the normal TDI data on the short and long axis of the left ventricle in adults aged 18-59*.

2. SUBJECTS AND METHODS

2.1. Subjects

126 volunteers (normal adults) were selected to participate in this study from 4.2009 to 7.2011 with normal results on ECG, echocardiography, and clinical examination. The ECG exercise test was taken for all persons aged 50-59 to exclude significant coronary heart disease.

2.2. Method

This is a cross-sectional study.

2.3. Material

+ Phillip Envisor CHD with M-mode, 2D, Doppler (pulsed TDI, Color), equipped with 2–4MHz phased array transducer (USA).

2.4. Doppler Echocardiographic Examination

Doppler echocardiographic images were obtained from parasternal and apical windows with the subject in the left lateral recumbent position. The echocardiogram and Doppler velocities were recorded on CD for further analysis.

2.5. Study parameter: including 6 segments of anterior and inferior wall of LV on the apical 2 chamber view; 2 segments (median anterior & median inferior) on parasternal short axis view at palpilary level. The Doppler parameters taken: Sm: peak systolic velocity. Em: diastolic velocity. Am: end-diastolic velocity (systolic atrial wave), and Em/Am rate.

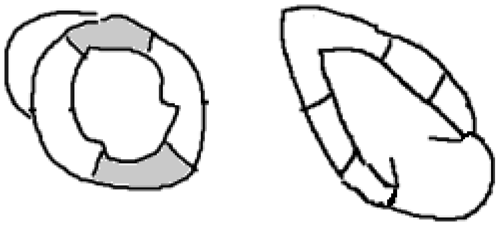

Figure 1: Segments of left ventricular wall on the short (1) and long (2) axis.

2.6. Data analysis: the software SPSS 19.0 was used.

3. RESULTS

3.1. M- mode echocardiography

Table 3.1. Results on M- mode echocardiography

	Parameters	Male(1) n=62	Female (2) n=64	Both sex n=126	p (1) & (2)
		X ± SD	X ± SD	X ± SD	
1	LVDd (mm)	48.01 ± 3.75	45.05 ± 4.15	46.51 ± 4.21	< 0.01
2	LVDd/BSA (mm/m^2	29.58 ± 2.21	30.50 ± 2.83	30.05 ± 2.57	< 0.05
3	LVDs (mm)	29.83 ± 3.01	27.21 ± 3.23	28.50 ± 3.38	< 0.01
4	LVDs/BSA (mm/m^2)	18.38 ± 1.79	18.42 ± 2.21	18.40 ± 2.00	> 0.05
5	IVSd (mm)	8.76 ± 1.29	8.24 ± 0.88	8.50 ± 1.13	> 0.05
6	IVSd/BSA (mm/m^2)	5.40 ± 0.80	5.57 ± 0.54	5.49 ± 0.68	> 0.05
7	IVSs (mm)	13.33 ± 1.63	12.25 ± 1.63	12.78 ± 1.71	< 0.05
8	IVSs/BSA (mm/m^2)	8.21 ± 1.02	8.28 ± 1.01	8.25 ± 1.01	> 0.05
9	LVPWd (mm)	8.39 ± 1.16	7.55 ± 1.33	7.97 ± 1.32	< 0.05
10	LVPWd/BSA (mm/m^2)	5.17 ± 0.68	5.10 ± 0.84	5.13 ± 0.76	> 0.05
11	LVPWs (mm)	14.56 ± 1.59	13.67 ± 1.79	14.11 ± 1.75	< 0.05
12	LVPWs/BSA (mm/m^2)	8.99 ± 1.09	9.25 ± 1.17	9.12 ± 1.14	> 0.05
13	LA (mm)	31.02 ± 3.62	28.90 ± 4.13	29.94 ± 4.02	< 0.05
14	LA/BSA (mm/m^2)	19.11 ± 2.20	19.51 ± 2.40	19.31 ± 2.30	> 0.05
15	AO (mm)	30.37 ± 3.36	28.09 ± 3.87	29.21 ± 3.79	< 0.01
16	AO/BSA (mm/m^2)	18.70 ± 1.87	19.02 ± 2.66	18.86 ± 2.30	> 0.05
17	LA/AO (mm)	1.03 ± 0.12	1.04 ± 0.15	1.03 ± 0.14	> 0.05
18	(LA/AO)/BSA mm/ m^2)	0.64 ± 0.93	0.70 ± 0.96	0.67 ± 0.10	> 0.05
19	EF%	69.34 ± 5.48	69.62 ± 6.01	69.50 ± 5.84	> 0.05
20	FS%	37.69 ± 4.28	39.98 ± 4.88	38.34 ± 4.62	> 0.05
21	LVM (g)	141.55 ± 29.35	113.94±26.63	127.41±31.13	< 0.01
22	LVM/BSA (g/m2)	86.67 ± 15.26	76.59± 15.32	81.51± 16.05	< 0.05

Table 3.2. LV velocity on two chambers view by gender

LV Wall	Segment	Parameter	Male (1) n=62	Female (2) n=64	Both n=126	p (1) & (2)
Inferior	Basal	Sm(cm/s)	9.24 ± 1.84	9.10 ± 1.85	9.17 ± 1.89	> 0.05
		Em(cm/s)	14.11± 3.98	13.84± 3.77	13.97± 3.86	> 0.05
		Am(cm/s)	9.40 ± 2.79	8.78 ± 2.15	9.09 ± 2.50	> 0.05
		Em/Am	1.72 ± 1.02	1.69 ± 0.69	1.70 ± 0.86	> 0.05
	Median	Sm(cm/s)	8.37 ± 1.68	7.85 ± 2.08	8.11 ± 1.90	> 0.05
		Em(cm/s)	10.86± 3.23	10.53± 2.86	10.69± 2.99	> 0.05
		Am(cm/s)	7.70 ± 2.41	7.29 ± 2.10	7.49 ± 2.26	> 0.05
		Em/Am	1.67 ± 1.35	1.59 ± 0.72	1.63 ± 1.08	> 0.05
	Apical	Sm(cm/s)	6.91 ± 1.49	6.44 ± 1.72	6.67 ± 1.62	> 0.05
		Em(cm/s)	7.93 ± 2.35	7.91 ± 2.41	7.92 ± 2.37	> 0.05
		Am(cm/s)	5.49 ± 2.03	5.30 ± 1.91	5.39 ± 1.97	> 0.05
		Em/Am	1.64 ± 0.84	1.71 ± 0.95	1.68 ± 0.89	> 0.05
Anterior	Basal	Sm(cm/s)	10.85± 2.07	10.43± 2.21	10.64± 2.14	> 0.05
		Em(cm/s)	12.88± 3.38	12.23± 3.15	12.55± 3.27	> 0.05
		Am(cm/s)	8.26 ± 2.33	7.62 ± 2.07	7.93 ± 2.22	> 0.05
		Em/Am	1.70 ± 0.70	1.76 ± 0.82	1.73 ± 0.76	> 0.05
	Median	Sm(cm/s)	9.79 ± 2.29	9.16 ± 1.96	9.47 ± 2.14	> 0.05
		Em(cm/s)	10.39± 2.97	10.14± 2.41	10.26± 2.69	> 0.05
		Am(cm/s)	6.73 ± 2.17	6.64 ± 2.04	6.68 ± 2.10	> 0.05
		Em/Am	1.73 ± 0.82	1.67 ± 0.67	1.70 ± 0.74	> 0.05
	Apical	Sm(cm/s)	8.30 ± 2.14	8.06 ± 2.20	8.18 ± 2.17	> 0.05
		Em(cm/s)	7.74 ± 2.34	7.5 ± 1.97	7.63 ± 2.15	> 0.05
		Am(cm/s)	5.32 ± 1.74	5.25 ± 2.10	5.29 ± 1.93	> 0.05
		Em/Am	1.57 ± 0.58	1.65 ± 0.76	1.61 ± 0.68	> 0.05

Table 3.3. Comparison of LV velocity on the segments of anterior wall

Parameter (cm/s)	Anterior Wall				p		
	Anterior annulus (1)	Basal (2)	Median(3)	Apical (4)	1 và 2	2 và 3	3 và 4
Sm	10.09± 3.27	9.64 ± 2.14	9.47 ± 2.14	8.18± 2.17	< 0.01	> 0.05	< 0.05
Em	15.57± 3.94	12.55± 3.27	10.26± 2.69	7.63± 2.15	< 0.01	< 0.01	< 0.01
Am	9.66 ± 3.57	7.93 ± 2.22	6.68 ± 2.10	5.29± 1.93	< 0.01	< 0.05	< 0.05
Em/Am	1.61 ± 0.52	1.73 ± 0.76	1.70 ± 0.74	1.61± 0.68	> 0.05	> 0.05	> 0.05

Table 3.4. Comparison of LV velocity on segments of the inferior wall

Parameters (cm/s)	Inferior Wall				p		
	Inferior Annulus (1)	Basal (2)	Median(3)	Apical (4)	1 &2	2 & 3	3 & 4
Sm	10.17 ±2.89	9.17 ± 1.89	8.11 ±1.90	6.67 ± 1.62	<0.05	<0.05	<0.01
Em	16.56 ±5.25	13.97 ± 3.86	10.69 ± 2.99	7.92 ± 2.37	<0.01	<0.01	<0.01
Am	9.41±3.42	9.09 ± 2.50	7.49 ±2.26	5.39 ± 1.97	>0.05	<0.01	<0.01
Em/Am	1.75 ± 0.78	1.70 ± 0.86	1.63 ±1.08	1.68 ± 0.87	>0.05	>0.05	>0.05

Table 3.5. LV velocity on short axis by gender

Segment	Parameter	Male (1) n=62	Female (2) n=64	Both sex n=126	P (1) và (2)
Median anterior	Sm (cm/s)	5.38 ± 1.64	5.35 ± 2.29	5.36 ± 1.99	> 0.05
	Em (cm/s)	6.75 ± 1.96	6.85 ± 2.01	6.80 ± 1.97	> 0.05
	Am (cm/s)	4.84 ± 1.65	4.85 ± 1.60	4.85 ± 1.62	> 0.05
	Em/Am	1.58 ± 0.91	1.60 ± 0.86	1.59 ± 0.88	> 0.05
Median inferior	Sm (cm/s)	9.14 ± 1.68	8.50 ± 1.90	8.82 ± 1.81	> 0.05
	Em (cm/s)	15.19 ± 4.51	14.50 ± 4.25	14.84 ± 4.37	> 0.05
	Am (cm/s)	7.00 ± 2.60	6.50 ± 1.98	6.75 ± 2.31	> 0.05
	Em/Am	2.44 ± 1.10	2.43 ± 1.03	2.44 ± 1.06	> 0.05

Table 3.6. Comparison of LV velocity between the long axis and short axis

Segment	Parameters	Long axis	Short axis	p
Median anterior	Sm (cm/s)	9.47 ± 2.14	5.36 ± 1.99	< 0.01
	Em (cm/s)	10.26 ± 2.69	6.80 ± 1.97	< 0.01
	Am (cm/s)	6.68 ± 2.10	4.85 ± 1.62	< 0.01
	Em/Am	1.70 ± 0.74	1.59 ± 0.88	> 0.05
Median inferior	Sm (cm/s)	8.11 ± 1.90	8.82 ± 1.81	< 0.05
	Em (cm/s)	10.69 ± 2.99	14.84 ± 4.37	< 0.01
	Am (cm/s)	7.49 ± 2.26	6.75 ± 2.31	< 0.05
	Em/Am	1.63 ± 1.08	2.44 ± 1.06	< 0.05

4. DISCUSSION

The results showed the decreased LV velocities from basal segments to the apical regions ($p<0.05$). In general. the systolic velocities (Sm wave) were lower than the peak diastolic velocities (i.e Em wave) in most of the ventricular wall segments. Our study results were similar to Carlos Eduardo Suaide Silva [5] Henein M. [6] and other published research.

On the other hand, we found that it was very difficult to receive the TDI wave on the median anterior region of the LV short axis. There were 16.67% (21 cases) of subjects in whom we could not collect the TDI waves on that region. The direction of TDI waves on this region was different from the others (negative for Sm and positive for Em and Am) because the myocardial movement was in the opposite direction.

The table 3.6 showed that myocardial velocities of the median- anterior segment by the short axis were lower than the velocities measured by the long axis in the same region ($p <0.05$). Conversely, the Sm of the short axis was with the higher velocity than the Sm of the long axis. We had the same result for the Em but not for the Am. Our data resembled that of Oki [11], this author made a comparision of the inferior movement on the short and long axis of the left ventricle in 35 normal persons. They thought that the contraction of myocardial fibers was prominent in long axis for the inferior wall and the inferior septum in the pro- systolic period when the fiber's contraction on the short axis was dominated in the ejection time. Partho P. Sengupta had the same conclusion [12].

The data of our research helps to understand the normal physiologic velocities of myocardium. We also found the limitation of TDI on the LV short axis because of a measurement difficulty in the median anterior segment. We thought that it was not recommended to use the velocities of the anterior wall by the short axis for the conclusion of coronary heart disease.

Age also influenced the myocardial velocities. We found that the Em wave velocity reduced with age and Am wave velocity inscreased conversely ($p<0.05$). The systolic myocardial velocity also diminished with age but this difference was not significant ($p>0.05$). Márcia Duarte Pedone & col. Also found the diminution of Em velocity with age on the segments of lateral-basal wall and basal septum.[10]. Mahbubul Alam concluded a weak correlation between systolic velocity and age.[9]. Nguyễn Thị Khang's study showed the relationship between age and diastolic wave when the systolic wave was less affected by age [1]. For the short axis, however, we did not conclusively determine the influence of age on TDI wave.

In this study, we also found that the pulsed TDI of LV was similar in both genders. Park H.S. and Nguyễn Thị Khang had the same results. Hiroyuki et al (2008), however, found that the diastolic function decrease more early in post-menopausal females [7],[13].

5. CONCLUSIONS

TDI velocity decreased from valvular annulus to the apex of left ventricle. Am velocity inscreased with age when the Em velocity decreased. The Sm velocity was less affected by age. Gender may not influence myocardial TDI velocity. It was difficult to measure the left ventricular TDI waves of the anterior wall on the short axis.

REFERENCES

1. Nguyễn Thị Khang (2008), *Nghiên cứu một số thông số siêu âm Doppler mô ở người lớn bình thường*, Luận án chuyên khoa cấp II, Trường Đại học Y - Dược Huế.
2. Nguyễn Anh Vũ (2010), "Kỹ thuật ghi siêu âm, Doppler tim", *Siêu âm tim cập nhật chẩn*

đoán, Nxb Đại học Huế, tr.30- 50.

3. Nguyễn Anh Vũ (2010), "Bệnh mạch vành", *Siêu âm tim cập nhật chẩn đoán*, Nxb Đại học Huế, tr. 148-159.
4. Nguyễn Anh Vũ (2010), "Đánh giá chức năng thất trái và huyết động bằng siêu âm tim", *Siêu âm tim cập nhật chẩn đoán*, Nxb Đại học Huế, tr. 201-243.
5. Carlos Eduardo Suaide Silva, Luiz Darcy Cortez Ferreira, Lucian Braz (2002), Study of the Myocardial Contraction and Relaxation Velocities through Doppler Tissue Imaging Echocardiography. A New Alternative in the Assessment of the Segmental Ventricular Function, *Arq. Bras. Cardiol,* 78, pp.766-782.
6. Henein M., Lindqvist P., Francis D. et al (2002), Tissue Doppler analysis of age-dependency in diastolic ventricular behaviour and filling, *Euro -pean Heart Journal,* 23, pp. 162-171.
7. Hiroyuki Okura, Yuko Takada, Azusa Yamabe, Tomoichiro Kubo et al (2009), Age- and Gender-Specific Changes in the left Ventricular Rela -xation, A Doppler Echocardiographic Study in Healthy Individuals, *Cicr Cardiovasc Imaging,* 2, pp.41-46.
8. Hyeun S. Park, Sansai D. Naik, Wilbert S. Aronow, Chul W. Ahn and et al (2007), Age- and Sex-Related Differences in the Tissue Doppler Imaging Parameters of Left Ventricular Diastolic Function, *Echocardio -graphy*, 24, pp. 567-71.
9. Mahbubul Alam, Johan Wardell, Eva Anderson et al (1999), Characteristic of Mitral and Tricupid Annular Velocities Determined by Pulsed Wave Doppler Tissue Imaging in Health Subjects, *J Am Soc Echocardiogr*,12, pp. 618-628.
10. Márcia Duart Pedone, Iran Castro, Domingos Hatem, José Carlos Haertel et al (2004), Changes in the Parameters of Left Ventricular Diastolic Function According to Age on Tissue Doppler Imaging, *Arquivos Brasileriros Cardiologia,* 83, pp. 466-469.
11. Oki T., Tabata T., Mishiro Y., Yamada H et al (1999), Pulsed tissue Doppler imaging of left ventricular systolic and diastolic wall motion velocities to evaluate difference between long abd short axes in healthy subjects, *J Am Soc Echocardiogr*, 12(5), pp. 308-313.
12. Partho P. Sengupta, Jagdish C. Mohan, Natesa G. Pandian (2002), Tissue Doppler Echocardiography: principles and applications, *Indian Heart J*, 54, pp. 368-378.
13. Park H.S., Naik S.D., Aronow W.S. et al (2007), Age- and -sex -related differences in the tissue Doppler imaging parameters of left ventricular diastolic dysfunction, *Echocardiography*,