

Evaluation of arterial pulse amplitude ratio and Valsalva ratio in different age groups

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2425 **ABSTRACT**

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Abstract

Aims: To construct normal values of Valsalva ratio for heart rate responses during Valsalva maneuver (VM) and arterial pulse amplitude ratio as reference values ^{FOR} of different age groups, and to investigate ^{we} the effect of aging alone, without presence of risk factors, on autonomic nervous system. *This is a*

~~Study design:~~ case control study.

~~Place and duration of study:~~ This study was performed in Marjan teaching hospital, in Hilla city, ^{from} during the period February 2012 to June 2012.

Methodology: 40 subjects were included in this study, all were healthy **males**, group¹ (G1) mean age ^{28.3} 28.3 ± 9.7 years, group² (G2) mean age ^{48.4} 48.4 ± 7.1 years. Strips of lead II of ECG were recorded during **performance** of VM for calculation R-R intervals and measurement of blood pressure during phase I and phase II by mercury sphygmomanometer. Calculation of Valsalva ratio for heart rate and arterial pulse amplitude ratio for both groups were done.

Results: The systolic and diastolic blood pressures of G2 were significantly higher than values of systolic and diastolic blood pressures of G1 at phase I and phase II of VM ($P=0.05$). ^{by} pulse pressure for the two groups at phase I (G1: 51 ± 11 , G2: 53 ± 13 mmHg) and phase II (G1: 41 ± 5 , G2: 41 ± 3.99) of VM were **not significant** ($P > 0.05$). Valsalva ratio for G1 was (1.5 ± 0.3) and for G2 was (1.39 ± 0.29), pulse amplitude ratio for G1 was (0.80 ± 0.19) and for G2 was (0.77 ± 0.19) ^{and} there were no significant differences between **the** two groups ($P > 0.05$). All values were expressed as mean $\pm$ SD.

Conclusions: The results showed that autonomic nervous system is ~~still~~ intact in the older group. The aging process, without the presence of risk factors, does not affect the autonomic nervous system.

27 Key words : Valsalva maneuver, Valsalva ratio, pulse amplitude ratio, autonomic function
28 tests.

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30 1. INTRODUCTION

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32 The Valsalva maneuver (VM) is performed by attempting to forcibly exhale while keeping
33 the mouth and nose closed, eliciting a complex series of changes in heart rate and blood
34 pressure, ^{which involve} involving both vagal and sympathetic responses. VM ^{is} used as a diagnostic tool to
35 evaluate the condition of the heart, and sometimes, as treatment to correct abnormal heart
36 rhythms or relieve chest pain [1]. There are four phases during the VM [2,3]. Phase I is the
37 onset of straining with increased intrathoracic pressure. The heart rate does not change but
38 the blood pressure rises. Phase II may be divided into early and late phases. In early phase
39 II, reduced preload and stroke volume lead to a fall in cardiac output despite tachycardia
40 caused by decreased vagal activity. Total peripheral resistance increases due to increased
41 sympathetic discharge (nucleus tractus solitarius) and increased plasma epinephrine
42 concentration. The fall in blood pressure is thus arrested, and is termed "late phase II". In
43 normal patients there is actually a rise in blood pressure just before release [4]. Phase III is
44 the release of straining with decreased intrathoracic pressure and normalization of
45 pulmonary blood flow. Phase IV marks ~~the~~ blood pressure overshoot (in the normal heart)
46 with reflex bradycardia.

47 Valsalva ratio: The Valsalva ratio is calculated as the ratio of the maximum R-R interval after
48 the strain of VM to that of the shortest R-R interval during the strain of VM. The normal

49 response is increased heart rate during phase II in response to the fall in blood pressure.
50 The baroreflex response to blood pressure overshoot in phase IV is transient bradycardia. A
51 ratio greater than 1.45 is considered normal, 1.20 to 1.45 as border line, and less than
52 1.20 as abnormal (autonomic dysfunction) [5]. According to Ewing et al [6] a Valsalva ratio
53 >1.21 is considered normal.

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55 Arterial pulse amplitude ratio is the ratio of the lowest pulse pressure during active straining
56 (phase II) to the greatest pulse pressure at onset of the strain. In dysautonomic patients,
57 there is typically loss of both blood pressure overshoot and reflex bradycardia [4].
58 Hébert et al [7] measured pulse amplitude ratio (i.e., minimum/maximum pulse pressure)
59 during strain phase of the VM in 20 adults (42 ± 14 yr), as part of their study, and found pulse
60 amplitude ratio ranging from 0.19 to 0.85 (0.45 ± 0.19) and The VM ratio ranged from 1.09 to
61 2.33 (1.56 ± 0.34).

62 Precaution of VM should not be performed by patients who have severe coronary artery
63 disease, have experienced recent heart attack, or have moderate to severe reduction in
64 blood volume. Risks of VM is that the patient may feel dizzy or faint during the procedure.
65 Serious consequences are rare. VM can cause blood clots to detach, bleeding, and
66 abnormal ventricular rhythms. It can also cause cardiac arrest. Consequently, the procedure
67 is usually performed in a setting where emergency equipment should be accessible.

68 In this study, we tried to construct normal values of Valsalva ratio for heart rate responses
69 during VM and arterial pulse amplitude ratio as reference values of different age groups and
70 also, we investigated the effect of aging alone, without the presence of risk factors on the autonomic
71 nervous system.

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2. MATERIAL AND METHODS / EXPERIMENTAL DETAILS / METHODOLOGY

(ARIAL, BOLD, 11 FONT, LEFT ALIGNED, CAPS)

-Subjects : 40 healthy male subjects were enrolled in this study . They were divided into two age groups, group¹ (G1) : 25 subjects with mean age 28.3 ± 9.7 years, mean body mass index (BMI) 22.8 ± 0.2 Kg/m². Group2 (G2) :15 subjects with mean age 48.4 ± 7.1 years, mean BMI 23.1 ± 0.01 kg/m². All subjects gave consent for the study, and approval was

obtained from the ethical committee at Kufa faculty of medicine. The subjects were from medical staff and relatives of patients. The subjects were thoroughly examined clinically by a cardiologist to confirm the inclusion criteria. Exclusion criteria included hypertension, diabetes mellitus, coronary heart disease and other cardiac problems, renal disease, and excluded any risk factors (e.g) smoking, hyperlipidemia. No subject was on any medication.

~~Mercury sphygmomanometer~~ Two devices were ^{used: one to measure} ~~needed~~ ^{one for} measuring blood pressure by auscultatory method and one for performing strain part of VM.

~~Electrocardiography (ECG)~~ to record ^{strip of lead II} ~~strip of lead II~~ during VM for calculation of R-R intervals at different phases of VM. ^{EKG was recorded}

Methods: ^{The} subject ^{placed} was put in the supine position, ^{with} and limb leads electrodes were connected

to the subject. After reaching a steady state , which means that heart rate in consecutive minutes changes by less than 3 beats/min [8] ,the subject exhaled forcefully after normal inspiration into a tube that was connected to another sphygmomanometer . A tiny air leak was placed in the tube to ensure that the airway pressure was produced from the thoracic cavity and not pharynx [9]. VM was performed at a pressure of 40 mmHg for 15 seconds [10]. The measurement of blood pressure was obtained at the beginning of a straining-phase I, then the VM was repeated after reaching the steady state to measure the blood pressure during phase II , which is occurred after 5 seconds of beginning of straining [7]. continuous ECG was recorded starting 1 min before the maneuver (resting period), during the maneuver (strain period, 15 sec.) and 60 seconds subsequent to the strain period [11]. After that

measurement of pulse pressure in phase I and phase II according to the equation: pulse pressure = systolic blood pressure - diastolic blood pressure. Then pulse amplitude ratio = minimum/maximum pulse pressure. VM ratio was calculated from longest R-R interval (during phase IV)/shortest R-R interval (during phase II) [5].

Statistical analysis: All values were expressed as mean $\pm$ SD, comparison between G1 and G2, done by unpaired student t-test, P -value < 0.05 considered statistically significant.

2. RESULTS

In G1: the systolic and diastolic blood pressure at phase I of VM were 150 ± 11.1 and 99 ± 7.2 mmHg, respectively. Maximum pulse pressure at phase I of VM was (mean $\pm$ SD = 51 ± 11 mmHg), which was the result of systolic blood pressure - diastolic blood pressure during phase I of VM. The systolic and diastolic blood pressure at phase II of VM were 136 ± 9 and 95 ± 7 mmHg, respectively. Minimum pulse pressure at (phase II) was 41 ± 5 mmHg. This resulted in pulse amplitude ratio (minimum/maximum pulse pressure) = (0.80 ± 0.19) .

R-R interval during phase II was 0.64 ± 0.1 s and during phase IV was 0.96 ± 1.2 s. The Valsalva ratio was 1.5 ± 0.3 .

In G2: maximum (phase I) pulse pressure (mean $\pm$ SD = 53 ± 13 mmHg) from (160 mmHg - 107 mmHg), and minimum (phase II) pulse pressure (41 ± 3.99 mmHg) from (146 mmHg - 105 mmHg). This resulted in pulse amplitude ratio (minimum/maximum arterial pulse pressure) = (0.77 ± 0.19) .

R-R interval during phase II was 0.68 ± 0.012 s and during phase IV is 0.95 ± 0.01 s. The Valsalva ratio was 1.39 ± 0.29 .

The systolic and diastolic blood pressures of G2 were significantly higher than values of systolic and diastolic blood pressure of G1 at phase I and phase II of VM ($P = 0.05$), but there

were no significant differences between pulse pressure at phase I and phase II of VM of the two groups ($P>0.05$), and there were no significant differences between pulse amplitude ratio and Valsalva ratio of both groups ($P>0.05$). Table-1, figure-1.

Table-1 Hemodynamic parameters during phase I and phase II of VM of G1 and G2. Values were expressed as mean $\pm$ SD.

Parameters	G1 28.3 $\pm$ 9.7 years	G2 48.4 $\pm$ 7.1 years	P value	Significance
Systolic blood pressure at phase I of VM*** (mmHg)	150 $\pm$ 11.1	160 $\pm$ 9.1	S*	$P=0.05$
Diastolic blood pressure at phase I of VM (mmHg)	99 $\pm$ 7.2	107 $\pm$ 8.2	S	$P=0.05$
Systolic blood pressure at phase II of VM (mmHg)	136 $\pm$ 9	146 $\pm$ 7	S	$P=0.05$
Diastolic blood pressure at phase II of VM (mmHg)	95 $\pm$ 7	105 $\pm$ 4	S	$P=0.05$
Pulse pressure at phase I of VM (mmHg)	51 $\pm$ 11	53 $\pm$ 13	NS**	$P>0.05$
Pulse pressure at phase II of VM (mmHg)	41 $\pm$ 5	41 $\pm$ 3.99	NS	$P>0.05$

S* significant difference, NS** no significant difference, VM***-Valsalva maneuver