

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

4

5

6 **Yesar MH AL-Shamma^{1*}, Amir S AL-Mu'min^{2*}, Ahlam KA AL-**
7 **Hamdany^{3*}.**

8

9

10 **1.PhD PHYSIOLOGY(UK). DEPARTMENT OF**
11 **PHYSIOLOGY,COLLEGE OF MEDICINE, KUFA UNIVERSITY.**

12 **2.INTERVENTIONAL CARDIOLOGY ,F.I.C.M.S. DEPARTMENT**
13 **OF MEDICINE , COLLEGE OF MEDICINE, BABYLON UNIVERSITY.**

14

15 **3.PhD PHYSIOLOGY. DEPARTMENT OF**
16 **PHYSIOLOGY,COLLEGE OF MEDICINE,BABYLON UNIVERSITY**

17

18

19

20

21

22

23

24

25 **ABSTRACT**

26

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 of different age groups, and to investigate ^{the} effect of aging alone without presence of risk factors on autonomic nervous system.

Study design: case control study.

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

Methodology: 40 subjects were included in this study, all were healthy male^s, group1 (G1) ~~with~~ mean age (28.3 ± 9.7) years ~~with~~, group2 (G2) ~~with~~ mean age (48.4 ± 7.1) years ~~with~~. Strips of lead II of ECG were recorded during performing ^{phase 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 pressure^s 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 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 ~~differences~~ ($P > 0.05$). 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 older group. this may conclude that aging process, without the presence of risk factors, does not affect autonomic nervous system.

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

29

30 1. INTRODUCTION

31

32 The Valsalva maneuver (VM) is performed by attempting to forcibly exhale while keeping the
33 mouth and nose closed, Eliciting a complex series of changes in heart rate and blood
34 pressure involving both vagal and sympathetic responses. VM is used as a diagnostic tool to
35 evaluate the condition of the heart and, sometimes, as a treatment to correct
36 abnormal heart rhythms or relieve chest pain [1]. There are four phases during the Valsalva
37 maneuver [2,3]. Phase I is the onset of straining with increased intrathoracic pressure.
38 The heart rate does not change but blood pressure rises. Phase II may be divided into early
39 and late phases. In early phase II, reduced preload and stroke volume lead to a fall in
40 cardiac output despite tachycardia caused by decreased vagal activity. Total peripheral
41 resistance increases due to increased sympathetic discharge (nucleus tractus solitarius) and
42 increase in plasma epinephrine concentration. The fall in blood pressure is thus arrested,
43 and is termed "late phase II"; in normal patients there is actually a rise in blood pressure just
44 before release [4]. Phase III is the release of straining with decreased intrathoracic
45 pressure and normalization of pulmonary blood flow. Phase IV marks the blood pressure
46 overshoot (in the normal heart) 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 ~~an~~ increase ~~in~~ heart rate during phase II in response to the fall in blood
50 pressure, and the baroreflex response to ~~the~~ blood pressure overshoot in phase IV is
51 transient bradycardia. A ratio of greater than 1.45 is considered normal, 1.20 to 1.45 as
52 border line, and less than 1.20 as abnormal (autonomic dysfunction) [5]. According to Ewing
53 et al [6] a Valsalva ratio >1.21 is considered normal.

54

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 ~~the~~ loss of both ~~the~~ blood pressure overshoot and ~~the~~ reflex bradycardia [4].
58 Hébert et al [7] measured ~~the~~ pulse amplitude ratio (i.e., minimum/maximum pulse
59 pressure) during ~~the~~ strain phase of the Valsalva maneuver in 20 adults (42 ± 14 yr) as part
60 of their study and found pulse amplitude ratio ranging from 0.19 to 0.85 (0.45 ± 0.19) and
61 ~~The Valsalva~~ ^{VM} ratio ranged from 1.09 to 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 ~~an~~ moderate to severe reduction in
64 blood volume. Risks of VM ^{is} that the patient may feel dizzy or faint during the procedure, but
65 serious consequences are rare. There is a risk that the VM can cause blood clots to detach,
66 bleeding, and abnormal rhythms originating in the ventricle. It can also cause cardiac arrest.
67 Consequently, the procedure is usually performed in a setting where emergency equipment
68 is accessible.

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

73

Patients

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 their consent for the study, approved and approval of 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 cardiologist to confirm the inclusion criteria. Exclusion criteria include 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 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 during VM for calculation of R-R intervals at different phases of VM.

The patient was and
Methods: Subject put in supine position, limb leads electrodes were connected to the subject. Mercury Sphygmomanometer was used for measuring blood pressure.

After reaching the steady state which means that heart rate in consecutive minutes changes by less than 3beats/min [8], the subject should exhale forcefully after a normal inspiration into a

tube that was connected to another sphygmomanometer. A tiny air leak was placed in the tube to ensure that airway pressure was produced from the thoracic cavity and not pharynx

[9]. *VM* ~~Valve~~ maneuver was performed at a pressure of 40 mmHg for 15 seconds

[10]. Measurement of blood pressure at the beginning of straining-phase, then repeated the VM after reaching the steady state to measure the blood pressure during phase II which is occur after 5 seconds of beginning of straining [7]. A continuous ECG was recorded starting

1 min before the maneuver (resting period), during the maneuver (strain period, 15 sec.) and

101 60 seconds subsequent to the strain period [11]. After that measurement of pulse pressure
102 of phase I and phase II according to equation: pulse pressure = systolic blood pressure -
103 diastolic blood pressure. Then pulse amplitude ratio = minimum/maximum pulse pressure.
104 Valsalva ratio ^{was} calculated from longest R-R interval (during phase IV) / shortest R-R
105 interval (during phase I) [5].

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

108

109 2. RESULTS AND DISCUSSION

110

111 In G1: the systolic and diastolic blood pressure at phase I of VM were 150 ± 11.1 and 99 ± 7.2
112 mmHg respectively, so maximum pulse pressure at phase I of VM was (mean $\pm$ SD = $51 \pm$
113 11 mmHg) which was ^{the} result of systolic blood pressure - diastolic blood pressure during
114 phase I of VM. ^{but} the systolic and diastolic blood pressure at phase II of VM were 136 ± 9 and
115 95 ± 7 mmHg respectively, so minimum pulse pressure at (phase II) (41 ± 5 mmHg). This
116 resulted in pulse amplitude ratio (minimum/maximum pulse pressure) = (0.80 ± 0.19) .

117

118 R-R interval during phase II ^{was} is 0.64 ± 0.1 s and during phase IV ^{was} is 0.96 ± 1.2 s so The
119 Valsalva ratio was 1.5 ± 0.3 .

120 In G2: maximum (phase I) pulse pressure (mean $\pm$ SD = 53 ± 13 mmHg) from (160 mmHg -
121 107 mmHg), and minimum (phase II) pulse pressure (41 ± 3.99 mmHg) from (146 mmHg -
122 105 mmHg). This resulted in pulse amplitude ratio (minimum/maximum arterial pulse
123 pressure) = (0.77 ± 0.19) .

124 R-R interval during phase II ^{was} is 0.68 ± 0.012 s and during phase IV ^{was} is 0.95 ± 0.01 s, so The
125 Valsalva ratio was 1.39 ± 0.29 .

126 The systolic and diastolic blood pressure of G2 were significantly higher than values of
 127 systolic and diastolic blood pressure of G1 at phase I and phase II of VM ($P=0.05$), but there
 128 were no significant differences between pulse pressure at phase I and phase II of VM of the
 129 two groups ($P>0.05$). ~~and~~ there were no significant differences between pulse amplitude
 130 ratio and Valsalva ratio of both groups ($P>0.05$). Table-1, figure-1.
 131 Table-1 Hemodynamic parameters during phase I and phase II of VM of G1 and G2. Values
 132 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	$P>0.05$

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

134

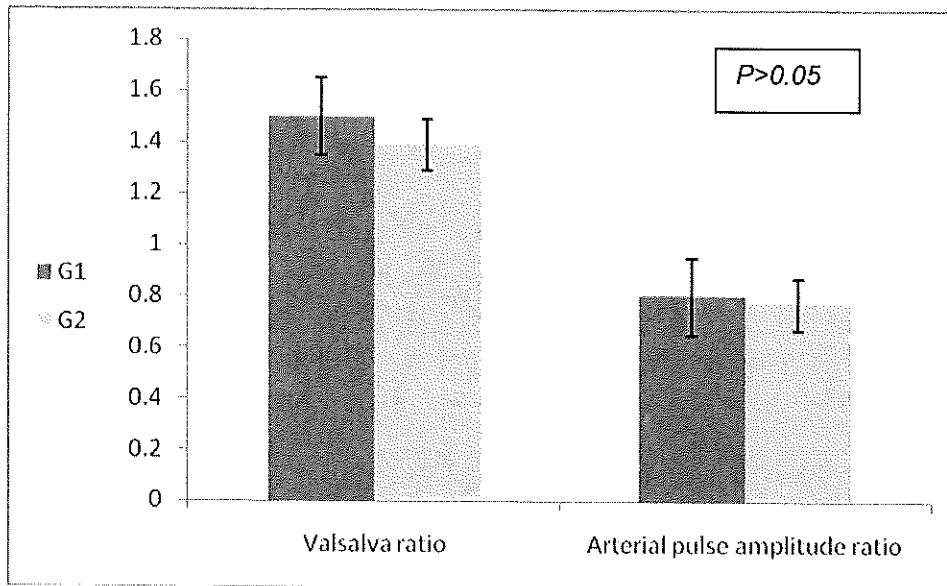


Figure-1: Comparison Valsalva ratio and pulse amplitude ratio between G1 and G2. (G1: group1(28.3±9.7)years old, G2: group2(48.4±7.1)years old. $P > 0.05$).

Discussion : Beside that VM is usually used to assess autonomic function [12,13], and from changes of heart rate responses during different phases of VM, and the changes of systolic and diastolic blood pressure, which reflect the integrity of autonomic function, arterial pressure response during the strain phase of the VM might reflect LV function [14,15], or right-sided pressures [16], or both [17,18,19]. Some authors have suggested that the pulse amplitude ratio may improve the assessment of cardiac status [19,20] and may furnish a noninvasive scale of myocardial dysfunction. So it seems of physiological interest to clarify this issue and measure values of different age groups which are normal, and then to continue this study in the future with different disease states. This study show that systolic and diastolic blood pressure of older group during phase I and phase II of VM were higher than the younger age, and this is due to fact that Increasing age is associated with increased intimal thickness, vascular smooth muscle hypertrophy, fragmentation of the internal elastic membrane and an increase in the amount of collagen and collagen cross-linking in arterial walls [21]. Intimal thickening occur even in population of low incidence of atherosclerosis [22]. But there were no significant differences between pulse pressure at phase I and phase II

153 of VM of the two groups , as pulse pressure depends on the compliance of blood vessel.

154 This mean that the compliance of blood vessels of the two groups were not different and give *providing*
155 *evidence of* idea about the healthiness of blood vessels of G2 .There were no significant differences of

156 pulse amplitude ratio of VM and Valsalva ratio of heart rate responses to VM of the two

157 groups .This may reflect *indicated* that the autonomic nervous system *is* still intact and *is* not affected *all*

158 by *the* vascular wall changes that occur during aging as *the* compliance of blood vessels *are* not

159 changed *in* . Gandhi et al [23] studied the association of autonomic functions with gender

160 by taking different age groups of both sex and the result of Valsalva ratio of *15-30* years old

161 group *which* was 1.51 ± 0.27 while *here* *46-60* years old group was 1.26 ± 0.10 *which* are nearly the

162 same of our results . We recommend to take other autonomic tests to evaluate this issue

163 about healthy aging people .

164 4. CONCLUSION

165 *we* Aging process by itself may not influence *the* autonomic function unless *there are* *the presence of*
166 other risk factors or cardiovascular disease.

167 ACKNOWLEDGEMENTS

168 We would like to express our deepest thanks to the staff members of Marjan Hospital for
169 their cooperation.

170

171

172

173