Original Research Article

Physiological and Biochemical Changes in Acute Heart Failure as A Sequent to Acute Myocardial Infarction

Ghafil Saihood Hassan
College of Medicine, University of Babylon, Hilla, IRAQ

E-mail: dr.g.saihood@gmail.com

Abstract

Acute heart failures (AHF) can develop after acute myocardial infarction (AMI) early or later. It is a major cause of mortality especially in old age. The aim of current study was to detect the site of infarction in AHF patients, evaluation of parameter of AHF and comparison with control group.

The present study was done in Marjan Medical City, Hilla, at cardiac center unit. Thirty (30) random patients of AHF sequent to AMI. They include (19male, 11female). The random control subjects include 30 healthy persons (20 male, 10 female) with matching age. The ages of both groups were 50 – 80 years. All patients were diagnosed by a specialist doctor. Medical history, physical examination, echocardiography, electrocardiography blood pressure measurement, body mass and laboratory tests (Serum troponin T and I, serum potassium, serum calcium and serum sodium) are performed to all subjects.

The incidence of DM, HT, and smoking in AHF were 56.7%,60%, and 73% respectively. The serum troponin T, serum troponin I, serum calcium, were increased significantly while serum potassium, serum sodium and EF were decreased significantly in AHF compared to control group. The most common site of infarction in AMI with AHF was anterior infarction. Parameters of AHF were increased significantly (HR, serum troponin T, serum troponin I, and serum calcium)while other parameters were decreased significantly (serum potassium, serum sodium, and ejection fraction) were decreased significantly compared with control group.

Key Words: Acute heart failure, acute myocardial infarction, ejection fraction.

الخلاصة

عجز القلب الحاد الناشئ من احتشاء العضلة القلبية الحاد يحدث بصوره مبكره او متاخره، ويعد عجز القلب سبب رئيسي للموت وخاصه في كبار السن. الهدف من الدراسه هو تحديد موقع الاصابه بالاحتشاء لدى مرضى عجز القلب و تقييم المعاييرالفسلجيه والكيمياويه ومقارنتها بمجموعة المقارنه. انجز البحث في مدينه مرج ان الطبيه –الحلة،في وحده العنايةِ القلبية المركزة. شملت الدراسه ٣٠ مريضا مصابون بعجز القلب الحاد بعد اصابته باحتشاء القلب الحاد (١٩ ذكر ،١١ انثى) و٣٠ شخصا سليما (٢٠ ذكر ، ١٠ انثى) تراوحت اعمارهم بين سن ٥٠ و٨٠ سنه. جميع اشخاص العينه (المرضى والسليمون) اختيروا بصوره عشوائيه والمرضى شخصو ا من قبل طبيب اختصاص . التاريخ المرضي، الفحص السريري، تخطيط القلب ،فحص الايكو ، قياس ضغط الدم ، كتله الجسم و الفحوصات المختبريه طبقت ع لى جميع الاشخاص سواء كانوا مرضى او سليمين. نسبه المصابين بفرط السكر ،فرط الضغط والمدخنين كانت ٥٦% ،٦٠%، ٧٣% على التوالي. مستوى التروبونين ت واي، الكالسيوم، وسرعة القلب كانت مرتفعة يشكل معنوي بـينما مستوى البوتاسيوم ،الصوديوم والجزء المطروح % من البطين الايسر كان قليل معنوي لدى مرضى عجز القلب. اظهرت الدراسةِ ان الموقع الاكثر عرضه للاحتشاء هو الجزء الامامي للبطين . والقيم المرتفعة معنوي هي مستوى التروبونين ت و ايو سرعه القلببينما القيم المنخفضة معنوياهي مستوى البوتاسيوم ، الصوديوم و الجزءالمطروح من البطين الايسر % مقارنة مرضى عجز القلب بمجموعه الاشخاص السليمين.

الكلمات المفتاحي ة: عجز القلب الحاد، احتشاء العضلة القلبية الحاد، الجزء المطروح %.

Introduction

Heart failure is common complication of myocardial infarction which may develop early or later. Understanding nature of risks could help patients that receive therapy [1].

It is becoming more common in adult older than 65 years because of increased survival after acute myocardial infarction and improved treatment of coronary artery disease (CAD), valvular disease, and hypertension. Heart failure is a common clinical syndrome characterized by dyspnea, fatigue, edema and pulmonary rales. Heart failure has high morbidity and mortality rates, especially in older persons. The initial evaluation includes a history and physical examination, chest radiography, electrocardiography, and laboratory assessment to identify causes or precipitating factors [2].

The ejection fraction (EF) is the most reprehensive parameter for HF by ECHO. The major trials in patients with HF and a reduced EF (HF-REF), or 'systolic HF', mainly enrolled patients with an EF≤35%, and it is only in these patients that effective therapies have been demonstrated to date [3].

After acute coronary occlusion, blood flow ceases in coronary vessels beyond the occlusion except for small amount of collateral flow from surrounding vessels. When the blood supply to part of myocardium is interrupted lead to irreversible changes an death of muscle cells [4].

The local muscle tissue become edematous and swell due to diminished cellular metabolism within few hours, no blood supply, the cardiac muscle cells die. Subendocardial muscles cells frequently become infarcted even there is no evidence of infarct in the surface portion of heart. The reason subendocardial muscle cells have difficulty obtaining adequate blood, is that the blood vessels in it, are compressed by systolic contraction of the heart, so damage of subendocardial regions occur first then spread toward the epicardium [5].

Cardiac troponin I and T are components of the contractile apparatus of myocardial cells. Elevations of these biomarkers in the blood reflect injury leading to necrosis of myocardial cells. The preferred biomarker is cardiac troponin I (cTn I) or cardiac troponin T (cTn T), which has high myocardial tissue specificity as well as high clinical sensitivity. Detection of a rise of the measurements is essential to the diagnosis of acute MI [6].

The systolic and diastolic hypertensions have been associated with an increased risk of AMI. The control of hypertension with appropriate medication has been shown to reduce the risk of MI significantly [7]. Cigarette smoking increases inflammation, thrombosis, and oxidation of low-density lipoprotein cholesterol [8].

It enhanced platelet activation, increased the likelihood of a thrombotic event, encouraged thrombus propagation, impaired the action of thrombolytic drugs and increased the chance of re-occlusion **[9].**

Physical activity (7 – 15 miles per week) of regular aerobic exercise increases serum HDL-C and decreases serum triglyceride (TG) [10].

Alcohol consumption has both favorable and unfavorable effects on metabolism, lipid profile, blood coagulation and fibrinolysis, blood pressure and vascular tone depending on the amount of alcohol consumed and the way that it is drunk [11]. Heart failure reduces output by activation of sympathetic nervous system (SNS). This leads to renal vasoconstriction and decrease glomerular filtration rate. This results in an increase reabsorption of sodium and water. And enhance renin-angiotensin –altos treron [12].

Materials and Methods

The patients of current study were thirty 30 patients with AHF (19 male, 11 female). The control subjects include 30 healthy persons (20 male, 10 female) with matching age. Age of both groups was 50 – 80 years. All patients were diagnosed by a specialist.

A history, physical examination, echocardiography, electrocardiography were obtained and laboratory tests were performed to all subjects. The present study was conducted at Cardiac Unit in Marjan Medical City, Hilla. February to April 2016.   Materials are electrocardiograph (ECG), echocardiograph (Echo), sphygmomanometer, centrifuge, weight and height scale, serum troponin T and I kit, serum potassium kit, Serum sodium ions kit, serum calcium ions kit.

Statistics analysis
SPSS version 17 was used. Student t test was used for comparison continuous data. These data expressed as mean ± SD or percentage [13].

Results
Effect of Gender of Patient on AHF
No significant difference in gender in AHF as shown in table 1. Therefore, the data of both sexes were polled together and were considered as one group.

Table 1: Comparison between female and male in AHF

N0.	Variables of AHF	Female (11)	Male (19)	P value
1	Age (years)	61.9±8.5	65±11.2	0.44
2	EF%	39.8±9.4	39.9±3.9	0.98
3	BMI (kg/m^2).	24.7±2.2	25.4±3	0.50
4	HR (beats/minute)	108.6±7.5	109.4±10.3	0.84
5	Serum troponin T(μg/ml).	58.5±18.1	56.5±23.4	0.44
6	Serum troponin I (ng/ml)	7.3±1.6	8.2±2.6	0.34
7	Serum calcium level(mg/dl)	9.3±0.6	9±1.2	0.45
8	Serum potassium level (mmol/l).	4.1±0.8	3.9±1.1	0.70
9	Serum sodium level (mmol/l)	141.6±4.8	140.9±6.9	0.75

Frequency of AHF:
The frequency of patients in Present Study according age group as shown in table (2).

Table 2 : Frequency of AHF according age group in present study

Age group in years	Frequency of AHF
50 -59	١٠
60 - 69	١٠
≥ 70	١٠
Total	٣٠

Site of infarction:
The sites of infarction in acute heart failure (AHF) are shown in table 3.

Table 3 : Sites of infarction of AHF

Site of infarction	Ant.	Inf.	Post.	AL.	AS	L	Total
No. of AHF	13	5	3	6	2	1	30
Percentage %	43.3%	16.7 %	10 %	20%	6.7%	3.3 %	100%

No.: Number. Ant.: Anterior. Inf.: Inferior.   Post. : Posterior. L: Lateral
AL: Anterolateral. AS: Anteroseptal. Ex.: Extensive.

History and clinical examination parameters:

A- Frequency of DM, HT, and smoking patients in AHF were shown in table 4.

Table 4: Frequency of DM, HT, and smoking patients in AHF (number =30).

Heart failure patients	Frequency	
	No.	%
DM	17	56.7
Hypertension	18	60
Smoking	٢٢	٧٣

B- Clinical examination parameters of patients and control groups:

Parameters of clinical examination between patients of AHF (30 patients) and control group (30 persons) with mating age were shown in table (5).

1-Ejection fractions of patients were decreased (39.9±6.3%) significantly (P value = <0.05) compared to control group (53.8±5.2%).

2- Body mass index of patients were increased (25.1±2.7 Kg/m^2) significantly (P value = <0, 05) compared to control group (23.6±1.7 Kg/m^2).

3- Heart rate of patients were increased (109.1±9.2 beats/min) high significant (P value= <0.01) compared to control group (73.6±13.9 beats/min).

Table 5 : Comparison between age, EF%, BMI, and HF of AHF patients and control groups

No.	Variables	Patients with AHF	Control subjects	Normal value	P =value
1	Age (years)	63.8±10.2	63.3±9.4		0.98
2	EF%	39.9±6.3	53.8±5.2	55- 80	< 0.05*
3	BMI (kg/m^2)	25.1±2.7	24.6±1.7	18 – 24.9	>0.05
4	HR (beats/minute)	109.1±9.2	73.6±13.9	60 -90	<0.01**

*Significant (P value =< 0.05)** high significant (P value = < 0.01)

C- Biochemical parameters between patients and control groups:

Comparison of biochemical parameters between patients of AHF (30 patients) and control group (30 persons) with matching age were shown in table 5.

1-Serum calcium level in patients (9.3±0.6 mg/dl) were increased significantly (P value = <0.05) compared to control group (9±1.2 mg/dl).

2-Serum potassium level in patient (4.1±0.8 mmol/l) were decreased high significantly (P value = < 0.01) compared to control group (3.9±1.1).

3-Serum sodium level in patients (141.2 ±6.1mmol/l) were decreased high significantly (P value = <0.01) compared to control group (150.2 ± 3.6).

4-Serum troponin T and I level in patients (58.5±18.1 µg/ml) (7.3±1.6 ng/ml) were increased high significantly (P value = <0.01) compared to control group (5.7±1.3 µg/ml) (0.8± 0.2 ng/ml) respectively. As shown in figure (6).

Figure 6: Biochemical parameters comparison between patient and control group

No.	Variables	Patients with AHF	Control subjects	Normal value	P value
1	Serum calcium level (mg/dl)	9±0.2	9.3±1.2	8.5 – 10.5	< 0.05*
2	Serum potassium level (mmol/l)	3.9±1.1	4.1±0.8	3.6 – 5.1	< 0.01**
3	Serum sodium level (mmol/l)	141.2±6.1	150.2± 3.6	135 -145	< 0.01**
4	Serum troponin level Tµg/ml	58.5±18.1	5.7±1.3	< 10	< 0.01**
5	Serum troponin I, ng/ml	7.3±1.6	0.8± 0.2	< 0.1	< 0.01**

5-Clinical examination and biochemical parameters:

Comparison between patients of AHF and control group according age groups as shown in table7, 8 and 9.

1-Ejection fraction % was decreased in patients with age 50 -59 years and 60 – 69 years (39.9 ± 1.96%, 37.3±8.7) high significant (P value < 0.01) compared to control group with same age (58.2 ± 2.8%, 52.1±5.7) respectively as shown in table 7,8. While it was decreased in patients with age ≥ 70 years (42.2±6.4%) significant (P value = <0.05) compared to control group with same age (51.2±3.9 %) as shown in table 9.

2- Heart rate (beats/min) was increased in patients with all ages (102±6.5, 107±7,116.5± 9) high significant (P value = < 0.01) compared to control group (74.4 ±7.1,76.2±6.2,70±22.7) respectively as shown in table 7, 8, 9.
.

3- Body mass index (Kg/m^2) in patients with age 50 – 59 years (24.2±2.09) was not significant (P value = 0.63) compared to control group (24.7±2.3) as shown in table 7. While it was significant in patient with age 60 -69 years, ≥ 70 years (P value = <0.01, <0.05) compared to control group (23.1±0.8, 23.1±1.3) respectively as shown in table 8,9.

4-Serum sodium with all age groups was decreased in patients (138±4.39, 140.5± 5.5144.8±6.8) significant (P value = < 0.01, <0.01<0.05) compared with control group (149.8±4.2, 151.1±3.9, 150±2.7) respectively with same age as shown in table 7, 8, 9.

5- Serum potassium level with all age group was decreased in patients (3.7±0.7, 3.6±1.3,4.1±1.4) significantly (P value = <0.05) compared with control group (3.9±0.4, 3.9 ±0.7, 4.6±0.7) respectively

Table 7: Comparison between AHF with control group at age 50 –59 years.

No.	Variable	Age 50 – 59 years			P value
		Patients with AHF	Control subjects	Normal value	
1	EF%	39.9±1.96	58.2±2.8	55 – 80%	0.01**
2	BMI (kg/m^2).	24.2±2.09	24.7±2.3	18.5 – 24.9	0.63
3	Serum Calcium level (mg/dl)	8.7±1.5	9.8±0.5	8.5 – 10.5	0.053
4	Serum potassium level (mmol/l)	3.7±0.7	3.9±0.4	3.6 – 5.1	0.05*
5	Serum sodium level (mmol/l)	138±4.39	149.8±4.2	135 -145	0.01**
6	HR (beats/minute)	102±6.5	74.4±7.1	60 -90	0.01**

*Significant (P value = < 0.05)   **high significant (P value = (0.01).

Table 8: Comparison between study variable in age 60 –69 years with normal value.

No.	Variable	Age 60 –69 years			P value
		Patients with HF (30)	Control group(30)	Normal value	
1	EF%	37.3±8.7	52.1±5.7	55 - 80	0.01**
2	BMI (kg/m^2).	25.4±2.1	23.1±0.8	18.5 – 24.9	0.05*
٣	Ca^{++} level (mg/dl)	9.5±0.7	9.7±0.7	8.5 – 10.5	.40·
٤	K$^+$ level (mmol/l)	3.6±1.3	3.9±0.7	3.6 – 5.1	.05*·
٥	Na$^+$ level (mmol/l)	140.5±5.5	151.1±3.9	135 -145	0.05*
٦	HR (beats/minute)	107±7	76.2±6.2	60 - 90	0.01**

* Significant (P value = < 0.05)   **high significant(P value = 0.01).

Table 9 : Comparison between variable studies at age ≥ 70 years with control group.

No.	Variable	Age ≥ 70 years			P value
		Patients with AHF(30)	Control group (30)	Normal values	
1	EF%	42.2±6.4	51.2±3.9	55 - 80	0.05*
2	BMI (kg/m^2).	25.8±3.7	23.1±1.3	18.5 – 24.9	0.05*
٣	Calcium level (mg/dl)	9.2±0.7	9.4±0.6	8.5 – 10.5	0.60
٤	Potassium level (mmol/l)	4.1±1.4	4.6±0.7	3.6 – 5.1	0.05*
٥	Sodium level (mmol/l)	144.8±6.8	150±2.7	135 -145	0.05*
٦	HR (beats/minute)	116.5± 9	70±22.7	60 - 90	0.01**

*Significant (P value = < 0,05) **high significant (P value = < 0.01)

Discussions
Site of Infarction in AHF:
In current study the most common site of infarction in AHF patients was anterior site**.** This result was in agreement with study of [14] who stated that the heart failure is more common after anterior infarction than other site, due to papillary muscles of mitral valve attach to anterior wall of left ventricle.

History and clinical examination:
Frequency of DM:
It was 56 % in AHF after AMI**.** DM accelerated condition of hypertension, coronary artery disease. It may contribute directly to cardiac dysfunction, increased local activation of the renin- angiotensin system [15].

Frequency of hypertension (HT):
It was 60%in AHF after AMI. The hypertensive patients seem to be related to endothelial damage, atherosclerosis, insulin resistance, left ventricular hypertrophy, and ventricular arrhythmias [16].

Frequency of smoking:
It was 76% in AHF after AMI. Cigarette smoking leads to impair endothelial function via decreased nitric oxide production. Also increase oxidative stress and activated in inflammatory pathway. [17].

Body mass index (BMI) kg/m^2 in patients of AHF (25.1±2.7) was increased but not significant (P value =<0.21) compared to control group (24.6±1.7). This result was agreement with (18)who reached that the average BMI became weaker and more limited effect on association with heart failure risk in AMI.

Heart rate (HR) beats/minute was increased in patients with AHF (102±6.5) high significant (P value=<0.01) compared to control group (73.6±13.9). This result was agreement with study by [19], who mentioned that myocardial ischemia is disorder balance between myocardial

oxygen demand and supply. Heart rate influences both factors.

Biochemical analyses:

Serum K level was decreased in patients with AHF (3.9±1.1 mmol/l) high significant (P value =<0.01) compared to control group (4.6±0.7 mmol/l. This result may be due to intake diuretic drugs with depletion of potassium or by use other drugs in management of AHF which decrease concentration of potassium concentration [20].

Serum calcium level was decreased in AHF (9 ± 1.2 mmol/l) significantly (P value =<0.05) compared to control group (9.3 ± 0.6mmol/l). **See table 5.** There is positive correlation between serum calcium and level of vascular calcification [21].

Serum troponin T and I level was increased in AHF (58.5± 18.1 µg/ml, 7.3±1.6 ng/ml) significantly (P value = 0.01) compared to control group (5.7 ±1.3 µg/ml, 0.8± 0.2ng). **Elevated cTn** values indicate of myocardial injury with necrosis.

Serum sodium level: Sodium level in heart failure was decreased (141.2 ± 6.1) significantly (P value =<0.01) compared to control group (150.2 mmol/l). This result may be due touse of diuretic drugs [22].

Clinical examination and biochemical parameters according age groups:

a- Ejection fraction % was decreased in patients with AHF in all age group, compared with control group due to systolic dysfunction.

b- Heart rate (beats/min) was increased in patients with all ages compared with control group due to sympathetic nervous system.

c- Body mass index (Kg/m^2) in patients with AHF at age 50 – 59 years was not significant, while it was significant in patient with age 60 -69 compared to control group because child and old age predisposal to low blood volume more than middle age.

d- Serum sodium (mmol/l) with patients of AHF in all age groups was decreased compared with control group due to secretion of antidiuretic hormones ADH from posterior lobe of pituitary gland and reach to kidney, where increase the permeability of water in distal duct to increase water reabsorption and excrete small concentrated urine.

e- Serum potassium level (mmol/l) with patients of AHF in all age groups was decreased compared with control group by better diuretic response.

Conclusion

The most common site of infarction in AHF was anterior infarction. Parameters of AHF were increased significantly (HR, serum troponin T, serum troponin I, and serum calcium) while other parameters were decreased significantly (serum potassium, serum sodium, and ejection fraction were decreased significantly compared with control groups.

References

1- Torabi A, Cleland GF, Rigby AS, Sherwi N. Development and course of heart failure after myocardial infarction in younger and older people. J Geriatr Cardiol. 2014; 11(1): 1-12.

2- King M, Kingery J, Casey B. Diagnosis and evaluation of heart failure. Am Fam (American Family) Physician 2012; 85(12): 1161-1168.

3- European Society of cardiology (ESC). Guidelines for diagnosis and treatment of acute and chronic heart failure 2012. European Heart Journal 2012; 33: 1787 – 1847.

4- Barrett KE, Barman SM, Boitano S, Brooks HL. Ganong's Review of medical physiology, 25[th]edition, international edition, New York by McGraw Hill Medical Company, 2016**.**

5. Jaffe AS, Babuin L, Apple FS. Biomarkers in acute cardiac disease. JAM Coll Cardiol **2006**; 48(1): 1 – 11.

6- Mehta PK; Wei J; Wenger NK. Ischemic heart disease in women: A focus on risk factors. Trends in Cardiovascular Medicine 2014; 25 (2): 140–151.

7-Ambrose JA, Barua R. The pathophysiology of cigarette smoking and cardiovascular disease. JAM Coll Cardiol 2004; 43 (10): 1731 -1737.

8- Williams IL, Noronha B, Zofaman AG. The management of acute myocardial infarction in patients with diabetes mellitus. British Journal of Diabetes and Vascular Disease 2003; 3 (5): 19- 24.

9- Vande-Werf F; Chairperson G; Bax B; Amadeo B; Blomstrom C; Crea F, Falk V. Management of acute myocardial infarction in patients presenting with persistent ST-segment elevation. European Heart J, 2008; 29, 2909–2945.

10- Ergene O, Biyik I. Alcohol and acute myocardial infarction. J Int Med Res 2007; 35 (1): 46 – 51.

11- Thomass KL, Velazquez EJ. Therapies to prevent heart failure post-myocardial infarction. Curr heart Fai Rep 2005; 2(4): 174 -182.

12- Filippatos TD, Elisaf MS. Hyponatreia in patients with heart failure. Word J cardiol. 2013; 5(9): 317 – 326.

13- Daniel WW. Biostatistics, eight editions, printed in the American Unites State, by Wiley Company, 2005.

14- Nasir S, Aguila D. Congestive heart failure and diabetes melalitus. Am J Cardiol. 2012; 110 (9): 50 – 56.

15- Kang DG, Jeong MH, Ahn Y, Chae SC, Itur SH, Hong TJ, Kim YJ, Seong IW, Chae J, Rhero JY, Chae IH, Cho MC, Bae JH, Rha SW, Kim CJ, Jang WS, Yoon J, Seung KB, Park SJ. Clinical effects of hypertension on the mortality of patients with acute myocardial infarction. J Korean Sci 2009; 24 (5): 800 – 806.

16- Gopal DM, Kalogeropoulos AP, Georgiopouleu VV, Smith AL, Bauer DC, Newman AB, Kim L, Bibbinc-Domingo K, Tindle H, Harris TB, Tang WWH, Kritchevsky S, Butler J. Cigarette smoking exposure and heart failure risk in older adult. Am Heart J. 2012; 164 (2):236 – 242.

17- Wang TK, Bolland MJ, Van-pelt NC, et al. Relationship between vascular calcification, calcium-metabolism bone density and fractures. J Bone mineral Res. 2010;25: 2777- 2785.

18- Janzky I, Romundstad P, Laugsard LE, Valten J, Mukamal KJ, Morkedal B. Weight and weight change and risk of acute myocardial infarction and heart failure- the HUNT study. J Intern Med. 2016; 280 (3): 312 – 322.

19- Fox K, Borer JS, Camm AJ, Danchin N, Ferrari R, et al. Resting heart rate in cardiovascular disease. J Amer College Cardiol 2007; 50 (9): 823 – 830.

20- Maclonaid JE, Struthers AD. What is the optimal serum potassium level in cardiovascular patients? J Amer College cardiol 2004; 43(2): 155 – 161.

21- Reid IR, Bolland MJ, Grey A. Does calcium supplementation increase cardiovascular risk? Climendocrinol (oxf) 2010; 73: 689 – 695.

22- Filippatos TD, Elisaf MS. Hyponatremia in patients with heart failure. World J Cardiol 2013; 5(9):317 – 328.