

Acute Coronary Syndrome in Young Adults: Does really exist? Findings from a retrospective study

Konstantinos Koutsampasopoulos,¹ Ioakeim Kirmpas,² Sofis Paradeisis,²
Athanasios Zotos,³ Michail Voulgaris,² Christina Ouzouni,⁴
Konstantinos Nakakis,⁵ Konstantinos Papaioannou²

**Οξύ Στεφανιαίο Σύνδρομο
σε Νεαρούς Ενηλίκους.
Υπάρχει Πραγματικά;
Ευρήματα από μια Αναδρομική
Μελέτη**

Περίληψη στο τέλος του άρθρου

¹MD, MSc, General Hospital of Chalkidiki,
Department of Cardiology, Polygyros,

²MD, General Hospital of Chalkidiki,
Department of Cardiology, Polygyros,

³MD, PhD, General Hospital of Chalkidiki,
Department of Cardiology, Polygyros,

⁴Associate Professor, Nursing
Department, Technological Educational
Institute of Sterea Ellada,

⁵Lecturer, Nursing Department,
Technological Educational Institute
of Sterea Ellada, Greece

Υποβλήθηκε: 02/10/2017

Επανυποβλήθηκε: 26/10/2017

Εγκρίθηκε: 06/11/2017

Corresponding author:

Christina Ouzouni,
Department of Nursing, TEI of Sterea Ellada
30 Km Old National Road, Lamia-Athens,
GR-351 00 Lamia, Greece
Tel: (+30) 2231 060 178
e-mail: ouzouni@teiste.gr

Introduction: Acute coronary syndromes (ACS) among young adults are extremely rare, poorly studied and the cardiovascular risk underestimated. **Purpose:** To evaluate the prevalence of ACS in patients younger than 40 years old, to determine their risk factors for coronary artery disease (CAD), as well as to correlate them with coronary angiography findings. **Material and Method:** A retrospective study was designed using data from patients' clinical records of a provincial hospital. All patients who were hospitalized for ACS in a cardiology department within four years of time were included in the study and patients under 40 years old were contacted to provide information about their own coronary disease risk factors and the results of their coronary angiography. **Results:** 1,004 patients (mean age 68.3 years-SD:12.84 years) were hospitalized with ACS. Eventually, 18 young patients fulfilled the criteria and participated in the present study. Participants mean age was 35.6±3.3 years old and most were men (72.2%). 9 patients (50%) presented as STEMI, 3 patients (16.7%) were hospitalized as NSTEMI and 6 patients (33.3%) with unstable angina. Of the participants 15 (83.3%) were reported as smokers, only one had a known coronary artery disease history, the same patient had a history of hypertension and diabetes mellitus type 2, while 5 patients (27.8%) had history of dyslipidemia and six (33.3%) had a positive family history of coronary heart disease. Coronary angiography was performed in 15 patients (83.3%) and six patients (33.3%) were found to have normal coronary arteries. **Conclusions:** ACS is a rare cause of hospitalization among young patients however, should not be overlooked. Risk factor profile had no relation with the type of ACS or the coronary angiography findings and in many cases one vessel disease or normal coronary arteries were identified.

Key words: Acute coronary syndrome, young patients, risk factors, coronary angiography.

Introduction

Coronary Artery Disease (CAD) is the most prevalent manifestation of cardiovascular diseases which is currently the major cause of death in industrialized countries. In the spectrum of CAD, Acute Coronary Syndromes (ACS) including ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTEMI), and unstable angina (UA) are associated with high mortality and morbidity.^{1,2}

ACS in young adults is extremely rare and poorly studied and the cardiovascular risk underestimated.^{3,4} In addition, the young patients with confirmed ACS were frequently found to have angiographically normal coronary arteries, or non-occluded vessel disease (with less than 70% stenosis), or single-vessel disease as compared to older patients⁵ and other causes such Kawasaki disease, cocaine and marijuana abuse, factor V Leiden, oral contraceptive use or even spontaneous coronary dissection are thought to cause the clinical manifestations of ACS.⁶⁻¹¹

Purpose of the study

The present study aimed to evaluate the prevalence of ACS in patients younger than 40 years old, to determine their risk factors for CAD as well as to correlate them with coronary angiography findings.

Material and Method

Methodology

A retrospective study was designed using data from clinical records of the patients, collected by two independent researchers. Greek patients, aged between 18 and 40 years old, who were hospitalized for ACS in the cardiology department of a provincial hospital within a four year period of time were included in the study. Study participants were classified according to the European Society of Cardiology Guidelines for ACS. Foreign patients were excluded from the study, because their follow-up would have been very difficult.

Subsequently, the patients were divided into two groups according to their age (those over 40 years old and those under 40 years old). In the group under 40 years old a follow-up was conducted by phone or, in special cases using a door to door approach. Patients were contacted to inquire about the result of coronary angiography.

The definition of ACS was based on the reported cardiac symptoms and signs, the ECG findings and the values of the cardiac markers: cardiac troponin T, creatine kinase (CK) or its MB isoenzyme (CK-MB) and this was done according to the European Society of Cardiology guidelines.^{1,2,12}

The demographic characteristics (age and gender) collected and studied from all hospitalized patients with ACS. Cardiovascular risk factors were recorded in phase two of the study when patients asked to provide information about the risk factors status at the time of ACS presentation. Hypertension was defined as blood pressure over 140/90 mmHg or treatment with antihypertensive agents, smoking as current or occasional smokers, diabetes mellitus as type 1 or 2, dyslipidemia as total cholesterol over 190 mg/dL or treatment with hypolipidemic agents and family history of coronary artery disease as a positive family history of premature coronary artery disease. Finally, young patients were asked about their past medical cardiovascular history (prior coronary artery disease, cerebrovascular or peripheral arterial disease, and abdominal aortic aneurysm).

Sample of the study

All patients who were hospitalized for ACS in a cardiology department within four years of time were included in the study and patients under 40 years old were contacted to provide information about their own coronary disease risk factors and the results of their coronary angiography. Of the 1004 patients (mean age 68,3 years-SD:12,84 years) who had hospitalized with ACS, eventually, 18 young patients (N=18) fulfilled the criteria and participated in the present study.

Statistical analysis

All analyses were performed with SPSS 21 software. Statistics were reported as Mean and SD, median with interquartile range or counts (%). Normality test have been done and variables were compared with the parametric t-test or the nonparametric Mann-Whitney U test, as appropriate. Chi-square and the Fisher's exact test were used to account differences for categorical variables. Tests were considered statistically significant at the level of 0.05 ($p \leq 0,05$).

Ethical issues

The present study was approved by the local ethics committee and was carried out in accordance with the World Medical Association's Declaration of Helsinki. All patients were informed of the aims of the study in order to consent to participate voluntarily in it.

Results

During the four years of data collection a total of 1004 patients (mean age 68.3 years-SD:12.84 years) were hospitalized in a cardiology department with ACS (STEMI, NSTEMI and UA) (table 1). Among them, 28 (n=4) patients were aged 40 years old or younger. Four (n=4)

Table 1. Baseline characteristics of young patients with ACS.

	overall (n = 18)	STE-ACS	NSTE-ACS	P	CHD	NO CHD	P
Age in years. mean \pm SD	35.6 \pm 3.3	35.0 \pm 1	36.2 \pm 1.3	0.321	35.0 \pm 0.9	36.7 \pm 1.5	0.364
Male. n (%)	13 (72.2)	7 (53.8)	6 (46.2)	0.618	9 (69.2)	4 (30.8)	0.710
RF. median (min-max)	1 (0-4)	1 (1-3)	2 (0-4)	0.481*	2 (1-4)	1 (0-2)	0.18*
Smoking status n (%)							
No smoker	1 (5.6)						
Previous smoker	2 (11.1)						
Occasional smoker	2 (11.1)						
Current smoker	13 (72.2)						
Smokers n (%)	15 (83.3)	8 (53.3)	7 (46.7)	0.588	10 (66.7)	5 (33.3)	0.755
If current smoker: pack-years mean \pm SD	18.46 \pm 8.9	17.78 \pm 9.1	19.5 \pm 9.4	0.729	18.5 \pm 10	18.4 \pm 7.2	0.985
Hypertension	1	0	1	0.471	1	0	0.446
Dyslipidaemia	5	2	3	0.437	4	1	0.395
Diabetes mellitus							
Type 1	1	0	1	0.437	1	0	0.647
Type 2			1		1		
Family history of premature CAD	6	3 (50)	3 (50)	0.627	5 (83.3)	1 (16.7)	0.261
Coronary artery disease	1	0	1	0.437	1	0	0.647

ACS: Acute Coronary Syndrome, STE-ACS: ST-Elevation Acute Coronary Syndrome, NSTE-ACS: Non –ST- Elevation Acute Coronary Syndrome, CHD: Coronary Heart Disease, P: P value, SD: Standard Deviation, RF: Risk Factors, CAD: Coronary Artery Disease, *Mann-Whitney U test

patients did not meet the inclusion criteria and did not participate in the study and 6 (n=6) patients were lost to follow up. Consequently, 18 (N=18) young patients participated in the study. Patients' mean age was 35, 6 \pm 3.3 years old and the majorities (72.2%) were men. Nine (n=9) patients (50%) presented as STEMI and all underwent fibrinolysis. Three (n=3) patients (16.7%) were hospitalized as NSTEMI and 6 patients (33.3%) presented with unstable angina. There were no statistically significant differences in age or gender of patients in the subgroups of ACS. With respect to investigating patients risk factors 83,3% reported as smokers (72.2% current and 11.1% occasional smokers), 11.1% as ex-smokers (had stopped smoking before the admission) and 56% patient reported as a non-smoker. The mean pack-years reported by smokers were 18.47 (SD:8.95 pack-years). Among young patients with Acute Coronary Syndrome only one had known coronary artery disease history previous [Percutaneous Coronary Intervention (PCI)]; the same patient had a history of hypertension and diabetes mellitus type 2, while 27.8% of the patients had history of dyslipidemia and 33.3% had a positive family

history of coronary heart disease. No patient had history of cerebrovascular disease.

All patients with STEMI underwent thrombolysis. Among ACS patients no one had died in hospital and no one developed major complications. One patient had died during follow up due to no cardiac causes (car accident) and information was given by relatives.

Coronary angiography was performed in 83,3% of the patients participated in the study, 5.6% underwent CT angiography and 11.1% were investigated by exercise testing. Of the patients who underwent coronary angiography, 33.3% were found to have normal or non-critical stenosis in coronary arteries and no intervention was necessary. In patients in whom PCI was performed, 27.8% were identified as having one-vessel disease, 16,7% two-vessel disease and 11.1% three-vessel disease (table 2).

In patients undergoing PCI, Right Coronary Artery (RCA) was in most cases the culprit vessel (6 patients), Left Anterior Descending (LAD) artery was involved in 4 patients and Left Circumflex (LCx) artery in 3 patients. It has to be stressed, that in two cases spontaneous coronary dissection detected during coronary angiography (in one

Table 2. Coronary Angiography findings.

	(N = 18)	STE-ACS	NSTE-ACS	P	CHD	NO CHD	P
ACS STEMI, n (%)	9(50)				8	1	0.06
NSTEMI, n (%)	3(16.7)						
UA, n (%)	6(33.3)						
Lesion-patients, n (%)	11 (61.1)	9	2	0.024	10	1	0.001
LAD, n (%)	4 (36.4)	3	1	0.721	3	1	0.364
LCx, n (%)	3 (27.3)	2	1	0.661	3	0	0.727
RCA, n (%)	6 (54.5)	5	1	0.424	6	0	0.455
Multivessel, n (%)	2 (11)	2	0	0.509	2	0	0.818
Single vessel, n (%)	9 (50)	6	3	0.509	8	1	0.818
Dissection, n (%)	2 (11.1)	1(50)	1 (50)	0.735	1 (50)	1 (50)	0.515

ACS: Acute Coronary Syndrome, STEMI: ST-Elevation Myocardial Infraction, NSTE-ACS: Non-ST-Elevation Myocardial Infraction, UA: Unstable Angina, P: P value, STE-ACS: ST-Elevation Acute Coronary Syndrome, NSTE-ACS: Non-ST-Elevation Acute Coronary Syndrome, CHD: Coronary Heart Disease, LAD: Left Anterior Descending, LCx: Left Circumflex, RCA: Right Coronary Artery

case in LAD and in the other case in RCA). Finally, in one case a possible Kounis Syndrome occurred as soon as ACS followed an allergic reaction treated with corticosteroids.

Patients who were found to have lesions with critical stenosis on coronary angiography were more likely to suffer from CAD and to present with STEMI compare to those with NSTEMI or UA ($p=0.001$ and $p=0.024$, respectively). Furthermore, patients with STEMI were more likely to have CAD compared to those with NSTEMI and UA ($p=0.024$). On the other hand, patients who presented with STEMI were more likely to undergo coronary angiography with subsequent PCI compared to patients who presented without STEMI, but this difference was not statistically significant ($p=0.105$).

No further statistically significant differences could be derived between risk factors and demographic/clinical characteristics in patients with STEMI and NSTEMI or UA.

Discussion

ACS is uncommon in young adults aged 40 years or less. In the present study 2.78% of ACS was diagnosed in young patients. According to the GREECS study which evaluated the prevalence of ACS in Greek population, 2% of male patients and 1% of female patients who participated in the study were aged 39 years or younger.¹³

Smoking is the most common and most constant risk factor among patients, but simultaneously, it is also the most modifiable risk factor. The high prevalence of smoking among young patients with ACS has been well-studied in the literature.¹⁴⁻¹⁷ Comparing results of the current

study with other epidemiologic studies in Greece, smoking was more common in younger than in older patients suffering from ACS.¹⁷⁻¹⁸

Zimmerman et al⁵ found that ACS was more prevalent only in young patients with family history of premature CHD, but the same study did not find differences between men and women,¹⁹ but other studies suggest that a positive family history of coronary artery disease is a main risk factor for young adults with Acute Myocardial Infarction.¹⁶

In studies which focused on cholesterol, hyperlipidemia is one of the most frequent risk factors in young patients with coronary heart disease. High plasma triglyceride and low HDL cholesterol levels were also associated with premature coronary artery disease.^{16,20,21}

Hypertension and diabetes mellitus appear to be less common in young patients with CHD than in older patients.⁵ However, it has to be noted that using the Framingham Risk Score for cardiovascular risk, one can underestimate the risk in young patients with myocardial infarction.^{4,22}

In most studies, young patients usually have multiple risk factors for CHD.²³⁻²⁵ In this study, only one patient had no risk factor and slightly less than half of the patients participated had two or more risk factors that were taken into account in the follow-up.

Younger patients have a higher incidence of normal coronary arteries and single-vessel coronary artery disease than older patients.^{5,25,26} There is no agreement in literature about the most frequent culprit artery, but the majority of studies suggest that in most cases of one-vessel disease, LAD is the most frequent culprit ar-

tery.^{5,25-28} In this study single vessel disease was identified in half of cases and in the majority, (60%) RCA was the culprit artery.

In two cases in the present study, a man and a woman, who came as a NSTEMI and STEMI in coronary angiography spontaneous coronary artery dissection occurred in RCA and LAD respectively. Spontaneous coronary artery dissection is a rare cause of acute myocardial infarction and is more common in younger patients and in women.²⁹

Rarer causes of ACS such as Kounis syndrome is supposed in one case when a 32 years-old patient presented as STEMI. Fifteen hours before the patient was nipped by a bee and he was treated with corticosteroids. Kounis syndrome otherwise allergic myocardial infarction or allergic angina is a cause of ACS caused by inflammatory mediators released during the allergic reaction.³⁰

Limitations

The present retrospective study had problems with missing data from patients' medical records. An effort was made to overcome this problem by communication with patients and using a strict protocol which excluded

all cases with limited data. In phase two of the study recall and information bias were noticed when information collected about risk factors. The small sample size is also a limitation of the study which produces limitations in external and internal validity of the study.

Conclusions-Recommendations

ACS is a rare cause of hospitalization among patients 40 years old or younger, but may occur at any age and should not be overlooked. Risk factor profile is not associated with the type of ACS or the coronary angiography findings and in many cases one-vessel disease or normal coronary arteries were identified. Rarer complications of ACS were 2 (out of 16) spontaneous coronary artery dissection and 1 case (out of 16) of Kounis syndrome. A further prospective longitudinal study is needed to examine both a) the relationship between risk factors of CHD and the appearance of ACS and b) using techniques like Coronary Flow Reserve (CFR) and Intravascular Ultrasound (IVUS) to improve the interpretation of the coronary angiogram.

Acknowledgements: Giannakou Rita RN, helped in collecting data.

Περίληψη

Οξύ Στεφανιαίο Σύνδρομο σε Νεαρούς Ενηλίκους. Υπάρχει Πραγματικά; Ευρήματα από μια Αναδρομική Μελέτη

Κωνσταντίνος Κουτσαμπασόπουλος,¹ Ιωακείμ Κίρμπας,² Σοφής Παραδείσης,² Αθανάσιος Ζώτος,⁴ Μιχαήλ Βούλγαρης,² Χριστίνα Ουζούνη,⁴ Κωνσταντίνος Νακάκης,⁵ Κωνσταντίνος Παπαϊωάννου²

¹Ιατρός, MSc, Γενικό Νοσοκομείο Χαλκιδικής, Πολύγυρος,

²Ιατρός, Γενικό Νοσοκομείο Χαλκιδικής, Πολύγυρος,

³Ιατρός, PhD, Γενικό Νοσοκομείο Χαλκιδικής, Πολύγυρος,

⁴Αναπληρώτρια Καθηγήτρια, Τμήμα Νοσηλευτικής, ΤΕΙ Στερεάς Ελλάδας,

⁵Καθηγητής Εφαρμογών, Τμήμα Νοσηλευτικής, ΤΕΙ Στερεάς Ελλάδας

Εισαγωγή: Τα οξεία στεφανιαία σύνδρομα (ΟΣΣ) στους νέους σε ηλικία ενηλίκους είναι εξαιρετικά σπάνια, έχουν μελετηθεί ελάχιστα και υποεκτιμάται ο καρδιαγγειακός κίνδυνος. **Σκοπός:** Να εκτιμηθεί ο επιπολασμός της στεφανιαίας νόσου σε ασθενείς ηλικίας μικρότερης των 40 ετών, να προσδιοριστούν οι παράγοντες κινδύνου τους για στεφανιαία νόσο, καθώς και να συσχετιστούν με ευρήματα στεφανιαίων αγγειογραφιών. **Υλικό και Μέθοδος:** Η παρούσα αναδρομική μελέτη σχεδιάστηκε χρησιμοποιώντας δεδομένα από τα αρχεία νοσηλευόμενων ασθενών επαρχιακής καρδιολογικής κλινικής. Συμπεριλήφθηκαν όλοι οι ασθενείς κάτω των 40 ετών, που νοσηλεύτηκαν σε μια χρονική περίοδο τεσσάρων ετών και καταγράφηκαν οι παράγοντες κινδύνου στεφανιαίας νόσου τους, καθώς επίσης και το αποτέλεσμα της στεφανιογραφίας τους. **Αποτελέσματα:** 1.004 ασθενείς με μέση ηλικία 68,3 έτη (SD: 12,84 έτη) νοσηλεύτηκαν με ΟΣΣ. 18 νέοι σε ηλικία ασθενείς, πληρούσαν τα κριτήρια εισόδου και συμπεριλήφθηκαν στην παρούσα μελέτη. Η μέση ηλικία τους ήταν 35,6 έτη (SD: 3,3 έτη) και οι περισσότεροι ήταν άνδρες (72,2%). Οι μισοί (9 ασθενείς/50%) νοσηλεύτηκαν με STEMI, 3 ασθενείς (16,7%) με NSTEMI και 6 ασθενείς (33,3%) με ασταθή στηθάγχη. Από τους συμμετέχοντες ασθενείς, 15 ασθενείς (83,3%) ήταν καπνιστές, ενώ μόνο ένας από αυτούς είχε διαγνωσμένη στεφανιαία νόσο. Ο ίδιος ασθενής είχε ιστορικό αρτηριακής υπέρτασης και σακχαρώδους διαβήτη τύπου 2, ενώ ιστορικό δυσλιπιδαιμίας εμφάνιζαν 5 ασθενείς (27,8%) και έξι (33,3%) είχαν θετικό οικογενειακό ιστορικό στεφανιαίας νόσου. Στεφανιογραφία πραγματοποιήθηκε σε

15 ασθενείς (83,3%), ενώ έξι ασθενείς (33,3%) βρέθηκαν με φυσιολογικές στεφανιαίες αρτηρίες. **Συμπέρασμα:** Τα ΟΣΣ αποτελούν σπάνια αιτία νοσηλείας σε νέους ασθενείς ωστόσο, δεν πρέπει να παραβλέπονται. Οι παράγοντες κινδύνου δεν συσχετίζονται με τον τύπο του ΟΣΣ ή με τα ευρήματα στεφανιογραφίας, ενώ σε πολλές περιπτώσεις διεγνώσθη νόσος ενός αγγείου ή φυσιολογικές στεφανιαίες αρτηρίες.

Λέξεις-ευρετηρίου: Οξύ στεφανιαίο σύνδρομο, νεαροί ασθενείς, παράγοντες κινδύνου, στεφανιογραφία.

✉ **Υπεύθυνος αλληλογραφίας:** Χριστίνα Ουζούνη, Τμήμα Νοσηλευτικής, ΤΕΙ Στερεάς Ελλάδας, 3ο Km Π.Ε.Ο Λαμίας – Αθηνών, 351 00 Λαμία, Τηλ: (+30) 2231060178, e-mail: ouzouni@teiste.gr

Βιβλιογραφία

- O'Gara PT, Kushner FG, Ascheim DD, Casey DE Jr, Chung MK, de Lemos JA et al. ACCF/AHA guideline for the management of ST-elevation myocardial infarction. A report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *Circulation* 2013, 127:e362–425
- Roffi M, Patrono C, Collet JP, Mueller C, Valgimigli M, Andreotti F, et al. ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation: Task force for the management of acute coronary syndromes in Patients Presenting without persistent ST-segment elevation of the European society of cardiology (ESC). *Eur Heart J* 2016, 37:267–315
- Rubin JB, Borden WB. Coronary heart disease in young adults. *Curr Atheroscler Rep* 2012, 14:140–149
- Shah N, Kelly AM, Cox N, Wong C, Soon K. Myocardial Infarction in the “Young”: Risk Factors, Presentation, Management and Prognosis. *Heart Lung Circ* 2016, 25:955–960
- Zimmerman FH, Cameron A, Fisher LD, Ng G. Myocardial infarction in young adults: angiographic characterization, risk factors and prognosis (Coronary Artery Surgery Study Registry). *J Am Coll Cardiol* 1995, 26:654–661
- Havakuk O, Rezkalla SH, Kloner RA. The Cardiovascular Effects of Cocaine. *J Am Coll Cardiol* 2017, 70:101–113
- Tanis BC, Bloemenkamp DG, van den Bosch MA, Kemmeren JM, Algra A, van de Graaf Y et al. Prothrombotic coagulation defects and cardiovascular risk factors in young women with acute myocardial infarction. *Br J Haematol* 2003, 122:471–478
- Yurtdaş M, Aydın MK. Acute myocardial infarction in a young man; fatal blow of the marijuana: a case report. *Korean Circ J* 2012, 42:641–645
- Burns JC, Shike H, Gordon JB, Malhotra A, Schoenwetter M, Kawasaki T. Sequelae of Kawasaki disease in adolescents and young adults. *J Am Coll Cardiol* 1996, 28:253–257
- Wolfe MW, Vacek JL. Myocardial infarction in the young. Angiographic features and risk factor analysis of patients with myocardial infarction at or before the age of 35 years. *Chest* 1988, 94:926–930
- Nettleton W, King V. The Risk of MI and Ischemic Stroke with Combined Oral Contraceptives. *Am Fam Physician* 2016, 94:691–692
- Thygesen K, Alpert JS, Jaffe AS, Simoons ML, Chaitman BR, White HD, et al. Third universal definition of myocardial infarction. *Eur Heart J* 2012, 33:2551–2567
- Pitsavos C, Panagiotakos DB, Antonoulas A, Zombolos S, Kogias Y, Mantas Y et al. Epidemiology of acute coronary syndromes in a Mediterranean country; aims, design and baseline characteristics of the Greek study of acute coronary syndromes (GREECS). *BMC Public Health* 2005, 5:23
- Adam AM, Rehan A, Waseem N, Iqbal U, Saleem H, Ali MA, et al. Prevalence of Conventional Risk Factors and Evaluation of Baseline Indices Among Young and Elderly Patients with Coronary Artery Disease. *J Clin Diagn Res* 2017, 11:OC34–OC39
- Chua SK, Hung HF, Shyu KG, Cheng JJ, Chiu NZ, Chang CM, et al. Acute ST-elevation myocardial infarction in young patients: 15 years of experience in a single center. *Clin Cardiol* 2010, 33:140–148
- Huang J, Qian HY, Li ZZ, Zhang JM. Comparison of clinical features and outcomes of patients with acute myocardial infarction younger than 35 years with those older than 65 years. *Am J Med Sci* 2013, 346:52–55
- Andrikopoulos G, Pipilis A, Goudevenos J, Tzeis S, Kartalis A, Oikonomou K et al. Epidemiological characteristics, management and early outcome of acute myocardial infarction in Greece: the HELlenic Infarction Observation Study. *Hellen J Cardiol* 2007, 48:325–334
- Andrikopoulos G, Tzeis S, Mantas I, Olympios C, Kitsiou A, Kartalis A et al. Epidemiological characteristics and in-hospital management of acute coronary syndrome patients in Greece: results from the TARGET study. *Hellen J Cardiol* 2012, 53:33–40
- Conti RA, Solimene MC, da Luz PL, Benjo AM, Lemos Neto PA, Ramires JA. Comparison between young males and females with acute myocardial infarction. *Arq Bras Cardiol* 2002, 79:510–525
- Chen L, Chester M, Kaski JC. Clinical factors and angiographic features associated with premature coronary artery disease. *Chest* 1995, 108:364–369

21. Malmberg K, Båvenholm P, Hamsten A. Clinical and biochemical factors associated with prognosis after myocardial infarction at a young age. *J Am Coll Cardiol* 1994, 24:592–599
22. Lee GK, Lee LC, Liu CW, Lim SL, Shi LM, Ong HY, et al. Framingham risk score inadequately Predicts Cardiac Risk in Young Patients Presenting with a First Myocardial Infarction. *Ann Acad Med Singapore* 2010, 39:163–167
23. Faisal AW, Ayub M, Waseem T, Khan RS, Hasnain SS. Risk factors in young patients of acute myocardial infarction. *J Ayub Med Coll Abbottabad* 2011, 23:10–13
24. Aggarwal A, Aggarwal S, Sarkar PG, Sharma V. Predisposing factors to premature coronary artery disease in young (age ≤ 45 years) smokers: a single center retrospective case control study from India. *J Cardiovasc Thorac Res* 2014, 6:15–19
25. Puricel S, Lehner C, Oberhänsli M, Rutz T, Togni M, Stadelmann M et al. Acute coronary syndrome in patients younger than 30 years aetiologies, baseline characteristics and long-term clinical outcome. *Swiss Med Wkly* 2013, 143:w13816
26. Garoufalos S, Kouvaras G, Vitsias G, Perdikouris K, Markatou P, Hatzisavas J et al. Comparison of angiographic findings, risk factors, and long term follow-up between young and old patients with a history of myocardial infarction. *Int J Cardiol* 1998, 67:75–80
27. Teixeira M, Sa I, Mendes JS, Martins L. Acute coronary syndrome in young adults. *Rev Port Cardiol* 2010, 29:947–955
28. Badran HM, Elnoamany MF, Khalil TS, Eldin MM. Age-related alteration of risk profile, inflammatory response, and angiographic findings in patients with acute coronary syndrome. *Clin Med Cardiol* 2009, 3:15–28
29. Tweet MS, Gulati R, Hayes SN. What Clinicians Should Know About Spontaneous Coronary Artery Dissection. *Mayo Clin Proc* 2015, 90:1125–1130
30. Kounis NG. Coronary hypersensitivity disorder: the Kounis syndrome. *Clin Ther* 2013, 35(5):563–571