DOI: 10.7860/JCDR/2015/15106.6458

Original Article

Forensic Section

Prevalence of Atherosclerotic Coronary Stenosis in Asymptomatic North Indian Population: A Post-mortem Coronary Angiography Study

YOGENDER SINGH BANSAL[1], SHATRUGAN PRASAD MANDAL[2], SENTHIL KUMAR[3], PUNEET SETIA[4]

ABSTRACT

Aim: A preliminary study of coronaries using post-mortem angiography was undertaken to see the prevalence of atherosclerotic coronary stenosis in non-cardiac unnatural deaths.

Materials and Methods: This study was conducted in a tertiary care centre located in Chandigarh. A total of 128 medico-legal cases were studied comprising 88 males and 40 females. Post-mortem examinations of these MLC cases were conducted in the Department of Forensic Medicine, PGIMER, Chandigarh. All hearts were visually screened by post-mortem coronary angiography first and then grossly examined using serial transverse incision technique in positive screening cases to find the degree of narrowing.

Results: Of the study group, 34% males and 20% females showed evidence of narrowing on angiography. Of the males showing coronary stenosis, 83% had single vessel disease and 13% had double vessel disease, while only one individual had triple vessel disease. In cases of female, all the cases of coronary stenosis were single vessel disease. Left anterior descending coronary artery (LAD) was the most common vessel involved, followed by right coronary artery (RCA) & Left circumflex artery (LCX) and in cases of double vessel disease, LAD in combination with LCX was responsible for 75% of the cases. Remarkably 23.6% of study population in the age group of less than 40 years showed appreciable narrowing in at least one of the coronaries.

Conclusion: In general, the prevalence of CAD is on the rise, particularly in younger population owing to the changes in their lifestyle and food habits. This preliminary study revealed evidence of narrowing of at least one coronary in 34% male and 20% female population and 23.6% subjects were less than 40 years old. Further detailed studies are needed especially in younger age group and to support the need for preventive cardiology in the early years of life.

Keywords: Atherosclerosis, Coronary artery disease, Post-mortem angiography, Unnatural deaths

INTRODUCTION

The prevalence of coronary artery disease (CAD) among Asian Indians is higher than among Europeans, Americans and other Asians [1,2]. Many studies infer that the case load of CAD in India is alarming. According to the World Health Report 2002, 45 million people in India are suffering from CAD and it is contributing to one fifth of the deaths in India and also, by the year 2020, CAD will account for one third of all deaths. The same report estimated that heart disease in Indian population occurs 10 to 15 years earlier than in the western people [3]. As many of these mortalities are going to be among young population, it will significantly affect the national productivity. Modern stressful lifestyle coupled with substance abuse, smoking, obesity, diabetes and hypertension are responsible for the increasing rate of CAD [4-8]. Some studies from India noted the regional variation in CAD and reported a higher prevalence in southern India than other regions of the country. According to a report from the Registrar General of India the mortality due to CHD is greater in southern India whereas stroke is more common in the Eastern Indian states [9].

It is a well-known fact that the prevalence of CAD has increased during the last three decades in developing countries particularly in India [10]. There are only few studies recording the prevalence of CAD in general population and many of them are almost three decades earlier. Most of these studies estimated mainly the prevalence of symptomatic CAD cases whereas asymptomatic cases-the hidden part of the iceberg is a major and most worrisome issue. Very few studies in India attempted to find the prevalence of asymptomatic CAD cases. In the present study the main aim was to assess asymptomatic atherosclerotic coronary stenosis cases in Northern India, which was achieved by post-mortem coronary angiography and correlated with serial incision technique in non-cardiac unnatural deaths.

MATERIALS AND METHODS

The study was conducted by the Department of Forensic Medicine, PGIMER and a tertiary referral hospital located in Chandigarh, India. This institute caters to nearly six states of Northern India including Punjab, Haryana, UT Chandigarh, Himachal Pradesh, Jammu & Kashmir and western part of Uttar Pradesh. A total 128 hearts were studied during autopsies of randomly selected subjects. Informed written consents were obtained from the legal heirs after explaining the aim and the nature of the study. The deceased preliminary data, clinical history and cause of death were noted in all cases. Cases suggestive of any past cardiac ailment were excluded from the study group. All hearts were examined by post-mortem coronary angiography. We adopted a simple technique demonstrated by Prahlow and co-workers for the post mortem coronary angiography [11]. In western countries this technique is routinely used in suspected CAD cases before dissection of hearts. In cases showing coronary stenosis in angiography, serial incision at 3mm interval was used to assess the degree of obstruction all along the length of coronary artery and based on this, cases were categorized into significant and non-significant atherosclerosis.

POSTMORTEM CORONARY ANGIOGRAPHY

Preparation of catheters

Two cardiac catheters of approximately 0.3 cm diameter each were taken. Each of these was cut so that each measured around 12-

18 inches in length. The tip of each was melted and flattened with a heat source (soldering iron) resulting in a lip with a slightly larger diameter than the catheter so that it stays fixed at a place.

Preparation of heart

The hearts were retrieved using the Virchow's method of dissection [11]. The heart chambers were gently flushed with water to remove blood and post mortem clot by making sure that the direction of flushing fluid corresponds to normal blood flow. Next, the patency of the proximal 0.5 cm of each coronary artery ostium was checked. The hearts were excluded from the study in cases of proximal coronary artery obstruction.

Cannulation

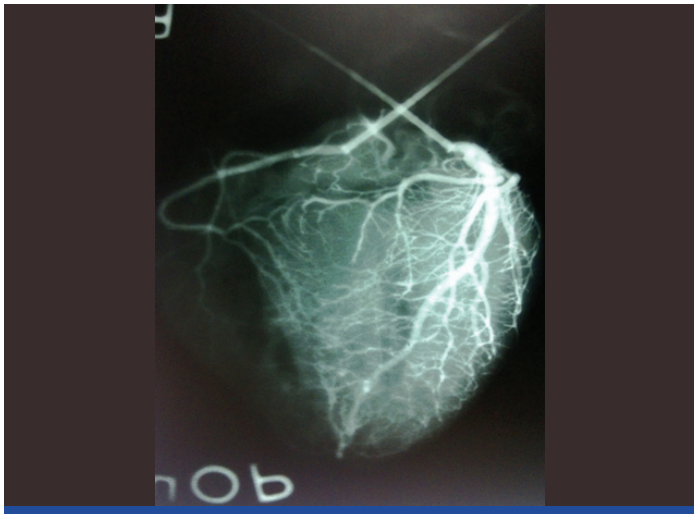
Two syringes were filled with barium sulphate solution and attached to the catheters. The contrast material was injected until it was expelled from catheter tips and due care was taken to avoid air bubbles in the syringes or catheters. Via blunt dissection, strings were passed under each proximal coronary artery, 0.5-1 cm from the ostium. Next, the catheter tip was carefully passed into the coronary artery ostia. After advancing the catheters for the distance of 0.5-1.0 cm, the strings around the coronary arteries were tied securely. The catheters were then slowly retracted until the tips abut the ligatures.

Radiography

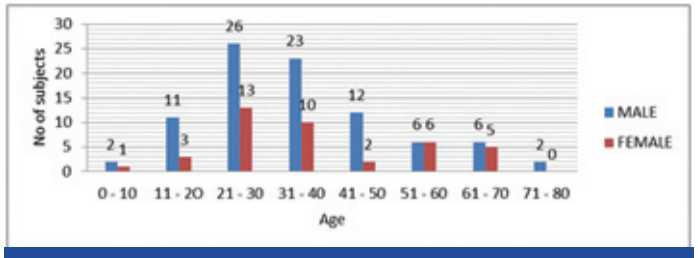
The heart with attached catheters and syringes was then placed on the specimen table in the anatomical position. The catheters and syringes were taped to the specimen table making sure they do not obstruct the X-ray. Now the contrast material was slowly injected following which the radiograph was taken. After taking the radiograph the films were developed and checked for their quality. [Table/Fig-1] shows the normal coronary angiogram.

Coronary artery dissection

After the visual inspection of post-mortem coronary angiogram, the hearts with narrowing of coronary artery were fixed in 10% buffered formalin. After fixation coronary arteries were cut transversely every 3 mm all along the length and grossly examined for the presence of atherosclerotic plaques, thickening and the degree of narrowing which was based on comparison with the adjacent normal portion of the coronary vessel. In suspected cases, tissues were taken for the microscopic assessment of atherosclerosis. Significant coronary atherosclerosis was defined as >50% reduction of lumen of coronary artery. According to the involvement of number of arteries we categorized them into single vessel disease, double vessel disease and triple vessel disease.



[Table/Fig-1]: Post-mortem coronary angiogram demonstrating normal coronary arteries



[Table/Fig-2]: Age-wise distribution of the study population

RESULTS

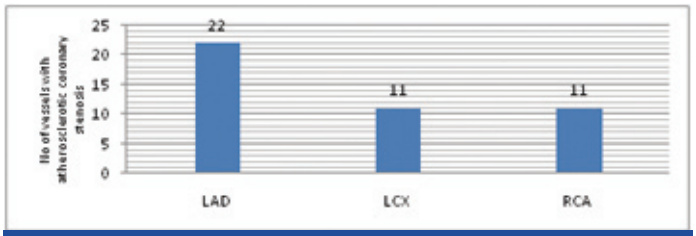
The present study was carried out on 128 hearts and the age of the subjects ranged from 6.5 years to 75 years with mean age was 34.8 years. Majority of patients belonged to 3rd decade of life followed by 4th and 2nd decade [Table/Fig-2]. A total of 88 (68.7%) cases were male and 40 (31.2%) cases were females. Mean age of males was 35.8 years and mean age of females was 30.7 years. In this randomly selected study group, the most common cause of death was road traffic accident (67%) followed by poisoning (11.7%), burns (7%) and fall from height (4.7%). In small percentage of study group other causes like assault, railway accidents, electric burn, machinery accident and septic abortion were noted.

It was found that atherosclerotic coronary stenosis was seen in 38 cases (29.7%) of the study group. Males accounted for 34% and females 20% [Table/Fig-3]. Older individuals had higher degree of atherosclerotic blockage compared to the younger. LAD was the most common vessel involved (50%), followed by RCA (25%) and LCX (25%) [Table/Fig-4]. In cases of double vessel disease, LAD in combination with LCX was responsible for 75% of the cases.

More than 50% narrowing of coronary lumen is considered as obstructive or significant atherosclerosis. In total 38 coronary stenosis cases 26 cases (68.42%) were non-obstructive types. The incidence of non-obstructive atherosclerosis was more in females (87.5%) than males (63.3%) in this study. Twelve cases (31.6%) out of 38 total coronary stenosis cases had significant atherosclerosis, majority of them were males (11 cases) and were in > 40 years age group.

Age group (years)	Male coronary stenosis	Female coronary stenosis	Total cases
11- 20	2	0	2
21- 30	7	4	11
31- 40	8	0	8
41- 50	3	2	5
51- 60	2	0	2
61- 70	6	2	8
71- 80	2	0	2
Total	30	8	38

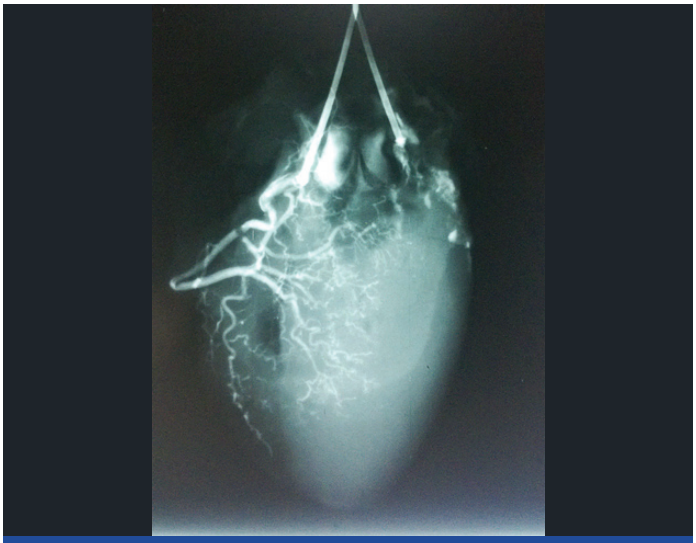
[Table/Fig-3]: Age & sex wise distribution of atherosclerotic coronary stenosis



[Table/Fig-4]: Pattern of atherosclerotic coronary stenosis

No of vessels involved	Male(n)	Female(n)	Total n (%)
1 Vessel disease	25	8	33(86.84)
2 Vessel disease	4	0	4(10.53)
3 Vessel disease	1	0	1(2.63)

[Table/Fig-5]: Number of vessel involved



[Table/Fig-6]: Post-mortem coronary angiogram showing triple vessel disease with complete obstruction of both LAD and LCX.

DISCUSSION

In 1649 Harney described the coronary circulation and its nutritive function to the heart. In 1772 Heberden clinically described angina pectoris. Despite these findings scientist never related the angina pectoris with CAD until 19th century. In 1879 it was Ludvig Hektoen, a pathologist who found that myocardial infarction is caused by blockage of coronary circulation secondary to sclerotic changes in coronaries. In 1918 Herrick described the ECG changes of cardiac infarction [12]. After this finding the diagnosis of MI was no longer difficult and it led to lot of researches regarding modern CAD epidemic. There is tremendous improvement globally in risk factor detection, diagnosis and treatment of CAD.

Different countries reported CHD epidemic in different times. CHD epidemic began in US in the early 1920s whereas Britain started to report in the 1930s. Previously, it was believed that CHD was the decease of old age & high socio-economic group of western population. Now it is no longer confined to age, socio-economic status or geographical boundaries. When the developing countries already started to report CAD epidemic, the incidence of CAD among younger population was also seen to be steeply raising globally [13]. The developed countries like USA, Australia, Canada, and New Zealand are showing a decline in CAD, but in developing countries particularly India, the prevalence of CAD has been on the rise during the last 3 decades. Despite of this trend of modern epidemic there are only few studies on its prevalence in general population and many of them are almost 3 to 4 decades old. Till date, it is very difficult to estimate the actual prevalence of CAD due to lack of proper case reporting, prospective large epidemiological studies and absence of centralized death registry [14]. A few Old independent epidemiological studies are available in North India which shows the increasing prevalence rate of CAD. In 1968 a study from Chandigarh (urban population) showed the CAD prevalence of 65.4 and 47.8 per 1000 males and females respectively [10]. Another study from a village of Haryana showed the prevalence of 22.8 and 17.3 per 1000 males and females respectively. In rural parts of Northern India, a two fold increase in the prevalence of CAD has been reported while in the urban area the prevalence has raised from 1% (1960s) to 9% (1990s) [10].

Most of these studies estimated mainly the prevalence of symptomatic CAD cases. But asymptomatic cases, the hidden part of the iceberg are the most worrisome aspect. Very few studies in India attempted to find the prevalence of these cases using clinical history, physical examination, ECG and questionnaire methods in living population. But by these methods the detection rate of asymptomatic cases is very minimal. We used postmortem angiography coupled with gross incisional technique in non-cardiac unnatural deaths to see the atherosclerotic coronary stenosis.

Postmortem angiography is generally under-used for autopsy purpose. It is extremely useful for determining the degree of narrowing in coronary and other small arteries. It also increases the ability of the autopsy surgeon to evaluate vascular diseases and helps to improve the forensic diagnosis. Various techniques of postmortem angiography are available in literature. Most of the techniques are time consuming and the same is the reason for postmortem angiography not being routinely done in forensic autopsies. We adopted a simple technique demonstrated by Prahlow and co-workers for post mortem coronary angiography [11]. In western countries post mortem angiography is routinely used in suspected sudden death cases before autopsy. The technique we used can be done even in primary health care centers of India and the X-ray films could be used as an evidence of atherosclerotic coronary stenosis in medico-legal cases.

In our study, a total of 88 (68.75%) cases were male and 40 (31.25%) cases were females. It showed more incidence of unnatural death among males than females which are more or less similar to most of the studies done in past [15-20]. The reason being that, as males are bread earners and dealing with outdoor activities, they are more vulnerable than females to accidents, violence, stress and life style related disorders. In the present study the most common cause of death was Road traffic accident (67.18%), followed by poisoning (11.71%), burns (7.03%) and fall from height (4.68%).

It was found that atherosclerotic coronary stenosis was appreciable on angiography in 29.68% of cases. Older individuals had higher degree of atherosclerotic narrowing compared to the younger individuals. Among the younger age group of 20 to 40 years, 26.38% of subjects showed narrowing of at least one of the coronaries. In comparison with other autopsy studies from Northern India, the prevalence of atherosclerosis in the present study was less. Singh H et al., from Punjab reported prevalence of 78% (80% in males and 66.6 % in females) [19]. Similarly Allison et al., found the prevalence as 82%, Murthy et al., as 73%, and Padmavati & Sandhu as 67.3% [17,18,21]. In the present study, prevalence of coronary stenosis was 34% in males and 20% in females. Similarly in the previous studies also prevalence of atherosclerosis was more in males than females. In this study, we have taken only those cases where stenosis was appreciable on angiogram X-ray films and further been classified as significant or non-significant which was based on the degree of stenosis on serial incisions throughout the length of the vessel and comparing the stenosis portion to the adjacent normal part. The same could be the reason for the low incidence of CAD in the present study when compared to other studies.

Of the males showing coronary stenosis, 83.3% had one vessel disease and 13.3% had two vessel disease, while only one individual had three vessel disease [Table/Fig-5,6]. In case of the females, all the cases of coronary stenosis were of one vessel disease. Among all coronary stenosis cases, single vessel involvement was seen in 86.8% while two vessels and three vessel involvements was seen in 10.5% and 2.6% cases. Single vessel involvement was the most common pattern in our study. This pattern is similar with study by Virmani et al., which showed more incidences for single vessel disease (44%) [22]. Study by Joshep et al., in young trauma victims showed prevalence of >50% narrowing as 20.7% and >75% narrowing as 9% [23]. Adding both these numbers accounted for 29.7% cases which is somewhere similar to our study of 31.6% of more than 50% coronary stenosis.

Left anterior descending artery was more frequently involved vessel (50%) in present study. This pattern is similar with a study from Punjab (Singh H et al.,) and a study from Chennai (Sudha et al.,) [19,24]. In cases of double vessel disease, LAD in combination with LCX was responsible for 75 % of the cases. Twelve cases out of 38 total CAD cases had significant atherosclerosis (>50% narrowing), in which 11 cases were males, 1 case was of female. Significant atherosclerosis was more commonly noted in older age groups than

younger age group. An 83.3% of significant atherosclerosis was in the age group of more than 40 years.

CONCLUSION

In general, the prevalence of CAD is on the rise, particularly in younger population owing to the changes in their lifestyle and food habits. This preliminary study revealed evidence of coronary stenosis in 29.7% of study population. Males had preponderance (34%) as compared to females (20%) and notably 26.38% of subjects in the age group 20 – 40 years had coronary stenosis. Further detailed studies are needed to confirm our findings and to support the need for preventive cardiology in the early years of life. Post-mortem coronary angiography coupled with histopathology is almost a full proof method for legal purposes to confirm death due to CAD.

ACKNOWLEDGEMENT

Thanks to Mr. AN Pandey research assistant for preparing hearts for post mortem angiography and to Mr. Ram Kumar, Museum technician for preservation and assisting in dissection of hearts. The authors also wish to thank all the staff of Forensic Medicine department, PGIMER, Chandigarh for their assistance in execution of this study.

REFERENCES

[1] Reddy KS. India wakes upto the threat of cardiovascular disease. *J Am Coll Cardiol*. 2007;50:1370-72.
[2] Gupta R. Recent trends in Coronary heart disease epidemiology in India. *Indian Heart J.* 2008;60(2suppl-B):B4-18.
[3] Alarming Statistics from India. [Internet] 2015 [Cited 2015 FEB 19]. Available from http://neocardiabcare.com/alarming-statistics-india.htm.
[4] World Health Organization. The World Health Report 2002. Geneva, Switzerland: WHO, 2002.
[5] Srinath RK, Yusuf S. Emerging epidemic of cardiovascular disease in developing countries. *Circulation*. 1998;97(6):596-601.
[6] Rastogi T, Vaz M, Spiegelman D, Reddy KS, Bharathi AV, Stampfer MJ, Willett et al. Physical activity and risk of coronary heart disease in India. *Int J Epidemiol*. 2004;33:759-67.
[7] Prabhakaran D, Shah P, Chaturvedi V, Ramakrishnan L, Manhapra A, Reddy KS. Cardiovascular risk factor prevalence among men in a large industry of Northern India. *National Medical Journal of India*. 2005;18(2):59.
[8] McKeigue PM, Shah B, Marmot MG. Relation of central obesity and insulin resistance with high diabetes prevalence and cardiovascular risk in South Asians. *Lancet*. 1991;337: 382-86.
[9] Gupta R, Guptha S, Sharma KK, Gupta A, Deedwania P. Regional variations in cardiovascular risk factors in India: India heart watch. *World Journal of Cardiology*. 2012;4(4):112-20.
[10] Ahmad N, Bhopal R. Is coronary heart disease rising in India? A systematic review based on ECG defined coronary heart disease. *Heart.* 2005;91(6):719-25.
[11] Walter EF, Philip CU, Richard LD. Autopsy Pathology: A Manual and Atlas. 2nd ed. Philadelphia: Saunders Elsevier; 2009. Chapter 7, Autopsy Photography and Radiology. Pp. 87-88.
[12] Nabel, Elizabeth G, Braunwald E. A tale of coronary artery disease and myocardial infarction. *New England Journal of Medicine*. 2012;366(1):54-63.
[13] Rose G. Oxford text book of public health, Vol.4, 1st ed. *Oxford*: Oxford University Press. 1985. pp.133.
[14] Sharma M, Ganguly NK. Premature coronary artery disease in Indians and its associated risk factors. *Vascular health and risk management*. 2005;1(3):217.
[15] Agravat AH, Dhruva GA, Babaria KR, Rathod KG. Coronary artery disease on autopsy: a five years clinicopathological study (November-2007 to October-2012). *International Journal of Biomedical and Advance Research*. 2013;4(2):105-11.
[16] Bhargava MK, Bhargava SK. Coronary atherosclerosis in North Karnataka. *Indian J Pathol Microbiol.* 1975;18:65-77.
[17] Murthy MSN, Dutta BN, Ramalingaswami V. Coronary atherosclerosis in North India (Delhi Area). *Journal of Pathology and Bacteriology*.1963;85:93-101.
[18] Padmavati S, Sandhu I. Incidence of coronary artery disease in Delhi from medico legal autopsies. *Indian Journal of Medical Research*. 1969;57:465-75.
[19] Singh H, Oberoi SS, Gorea RK, Bal MS. Athersclerosis in coronaries in Malwa region of Punjab. *Journal of Indian Academy of Forensic Medicine.* 2005;27(4):236-39.
[20] Tandon OP, Aggarwal VC, Katiyar BC. Coronary and aortic atherosclerosis. *Indian Heart J*. 1969;5:10.
[21] Allison RB, Rodriguez FL, Higgins EA, Leddy JP, Abel WH, Ellis LB, et al. Clinicopathological correlation in coronary. *Atherosclerosis Circulation.* 1963;27:170-84.
[22] Virmani R, Kolodgie FD, Burke AP, Farb A, Schwartz SM. Lessons from sudden coronary death – A comprehensive morphological classification scheme for atherosclerotic lesions. *Arterioscler Thromb Vasc Biol*. 2000;20:1262-75.
[23] Joseph A, Ackerman D, Talley D, Johnstone J, Kupersmith J. Manifestation of coronary atherosclerosis in young trauma victims- An autopsy study *Journal of Americal College of Cardiology*. 1993;22(7):459-67.
[24] Sudha ML, Sundaram S, Purushothaman KR, Kumar PS, Prathiba D. Coronary atherosclerosis in sudden cardiac death: An autopsy study. *Indian J Pathol Microbiol*. 2009-52:4869.

PARTICULARS OF CONTRIBUTORS:
1. Additional Professor, Department of Forensic Medicine, PGIMER, Chandigarh, India.
2. Assistant Professor, Department of Forensic Medicine, PGIMER, Chandigarh, India.
3. Senior Resident, Department of Forensic Medicine, PGIMER, Chandigarh, India.
4. Assistant Professor, Department of Forensic Medicine, AIIMS, Jodhpur, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Yogender Singh Bansal,
Additional Professor, Department of Forensic Medicine, Room No-1012,
Research B-Block, PGIMER, Chandigarh-160012, India.
E-mail: yogendrabansal@hotmail.com

FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Jun 03, 2015**
Date of Peer Review: **Jul 10, 2015**
Date of Acceptance: **Jul 20, 2015**
Date of Publishing: **Sep 01, 2015**