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Retraction

Retracted: Further Increase in the Expression of Activation Markers on Monocyte-Derived Dendritic Cells in Coronary Artery Disease Patients with Ectasia Compared to Patients with Coronary Artery Disease Alone

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Mediators of Inflammation has retracted the article titled "Further Increase in the Expression of Activation Markers on Monocyte-Derived Dendritic Cells in Coronary Artery Disease Patients with Ectasia Compared to Patients with Coronary Artery Disease Alone" [1]. This article has been retracted at the request of the authors.

References

[1] N. Yildirim, I. O. Tekin, M. Arasli, and M. Aydin, "Further Increase in the Expression of Activation Markers on Monocyte-Derived Dendritic Cells in Coronary Artery Disease Patients with Ectasia Compared to Patients with Coronary Artery Disease Alone," *Mediators of Inflammation*, vol. 2010, Article ID 748919, 6 pages, 2010.

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Clinical Study

Further Increase in the Expression of Activation Markers on Monocyte-Derived Dendritic Cells in Coronary Artery Disease Patients with Ectasia Compared to Patients with Coronary Artery Disease Alone

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Background. Coronary artery ectasia (CAE) is defined as localized or diffuse dilation of the coronary arteries. There are scarce data about the role of dendritic cells in CAE development. In this study we investigated the activation markers on the surface of monocyte-derived dendritic cells (mDCs) in coronary artery disease (CAD) patients with or without CAE. *Method*. The study consisted of 6 patients who had obstructive CAD with CAE, 6 CAD patients without CAE and 6 subjects with angiographically normal coronary arteries. mDCs were cultivated from peripheral blood monocytes. Surface activation markers were detected by flow cytometry. *Results*. CAD patients with CAE were detected to have significantly higher mean fluorescence intensities of CD11b, CD11c, CD54 , CD83, CD86 and MHC Class II molecules on mDCs in comparison to CAD patients without CAE and normal controls ($P < .001$ for all). A significant positive correlation was found between the number of vessels with CAE and the levels of CD11c, CD86, and MHC Class II molecules. *Conclusion*. mDCs display an increased cell surface concentration of activation molecules in CAD patients with CAE compared to patients with CAD alone. DC activation may play an important role for CAE development in patients with CAD.

1. Introduction

Coronary artery ectasia (CAE) has been defined as segmental or diffuse luminal dilatation of the coronary arteries in coronary angiography [1]. CAE is a rare finding among coronary artery anomalies and considered to be congenital in 10–20% of the cases while the remaining are acquired in origin [2]. The common coexistence of CAE with coronary artery disease (CAD) suggests that it may be a variant of atherosclerosis [2, 3]. However it is not clear why some patients with obstructive CAD develop CAE whereas most do not.

Dendritic cells (DCs) are potent antigen presenting and immune modulating cells with the unique ability to initiate a primary immune response to certain antigens by the activation of T lymphocytes [4, 5]. To acquire the ability to contact and activate T cells, DCs must undergo a maturation process with the upregulation of antigen presenting molecules including MHC class I and class II, adhesion molecules (CD11a, CD11b, CD54, CD50, CD58) and costimulatory molecules (CD40, CD80, CD86) [4–6]. In addition to these relatively well-known cell surface molecules; CD83 which is the hallmark of mature DCs and CD11c expressions were also reported to have functions in the regulation of antigen presentation and enhancement of T cell activation in the recent reports [7, 8]. During the development of an adaptive response, T cells form direct contacts with DCs and respond to peptide antigen displayed on MHC Class II and Class I molecules present on DC surfaces. In DC/T cell interactions, the presence of costimulatory molecules is required for T cell activation and differentiation into effector cells [6].

So far the presence of DC was described in atherosclerotic plaques of carotid arteries, aortas, and stenotic aortacoronary vein bypass grafts [9]. The colocalization of DC and T cells as well as the expression of MHC-II and costimulatory molecules on DCs in atherosclerotic plaques suggest that DC initiate an antigen-spesific immune response contributing to the progression of atherosclerosis [9–11]. Until now research on the pathogenesis of CAE has also focused on chronic transmural inflammation [2, 3]. Recently we have shown increased expression of monocyte and lymphocyte adhesion molecules in isolated CAE [12]. Given the pivotal function of DCs in initiating T lymphocyte responses in atherosclerosis and the knowledge that peripheral blood monocytes can be differentiated into DCs by exposure to inflammatory factors [13]; in the present study we investigated the expression levels of MHC Class II, CD54, CD11b, CD11c, CD83, and CD86 on the surface of monocyte-derived DCs (mDCs) in normal subjects and CAD patients with or without CAE. Our aim was to evaluate the role of DCs in CAE development.

2. Material and Methods

2.1. Study Population. The study was designed as a case control prospective study. The study population was selected from a series of 256 consecutive patients who underwent coronary angiography in our hospital between April 2006 and September 2006 due to the presence of chest pain or positive or equivocal results of noninvasive screening tests for myocardial ischemia. Out of 256 patients, 6 consecutive patients with obstructive CAD and CAE (Group 1, 4 male, mean age: 50.1 ± 4.0 years) and accepted to participate our study after giving informed consent, were identified and compared with age and sex matched 6 consecutive subjects with obstructive CAD alone (Group 2, 4 male, mean age: 51.1 ± 4.5) and 6 consecutive subjects who had angiographically shown normal coronary arteries (Group 3, 4 male, mean age: 51.1 ± 4.2). Obstructive CAD was defined as the stenosis of epicardial coronary artery >50% angiographically.

Exclusion criteria were the presence of previous myocardial infarction, acute coronary syndromes, any inflammatory or immunologic disease, active local or systemic infection, history of recent infection (<3 months), left ventricular dysfunction, left ventricular hypertrophy, cardiomyopathies, congenital heart disease, valvular heart disease, any abnormality in thyroid function test, arrhythmias and statin use within the last 6 months. Besides, leukocyte count, erythrocyte sedimentation rate and fibrinogen levels were normal in all patients and control subjects.

2.2. Coronary Angiography. Coronary angiography was routinely performed without the use of nitroglycerin. Selective coronary angiography was performed by means of Judkins technique in multiple projections. We used Iohexol (Omnipaque, Nycomed Ireland Cork, Ireland) as contrast agent during coronary angiography in all patients and control subjects. Coronary angiograms were analyzed by two blinded interventional cardiologists without knowledge of the clinical status and laboratory measurements of the subjects. The definition of CAE was that used in the Coronary Artery Surgery Study (CASS) [1]. According to the angiographic definition of CASS, a vessel is considered to be ectasic when its diameter is ≥1.5 times that of the adjacent normal segment in segmental ectasia. When there was no identifiable adjacent normal segment, the mean diameter of the corresponding coronary segment in the control group served as normal values. The number of epicardial coronary arteries with ectasia was analysed by use of a computerized quantitative coronary angiography analysis system (Philips BH 5000, Netherland).

2.3. Generation of Dendritic Cells and Cell Culture. Heparinized blood samples of the groups were drawn after coronary angiography from an antecubital vein with a 19-gauge needle without venous stasis in the fasting state. mDCs were generated according to an established method with minor modifications [13]. Peripheral blood mononuclear cells were isolated by density gradient centrifugation with Ficoll Hypaque 1077 density (PAA laboratories GMBH, Austria). Monocytes were isolated from peripheral blood mononuclear cells by their adherence to plastic. During 9 days of cell culture in the presence of RPMI-1640 medium (Sigma Chemical, Germany) supplemented with 10% FCS (Sigma Chemical) monocytes were differentiated into DC.

2.4. Flow Cytometric Analysis. The technique of flow cytometry involves the staining of blood cells with fluorescence tagged antibodies targeted to specific cell surface associated antigens. This is followed by quantification of fluorescence intensity in the cell population of interest as a measure of the specific antigen abundance and by determination of percentage of cells displaying fluorescence intensity beyond a threshold [4]. DC were incubated with the mouse antihuman, fluorescein isothiocyanate (FITC)-conjugated antibodies against CD14, CD11b, CD11c, CD54, CD83, CD86, and MHC Class II-phycoerythrin (Beckman Coulter, CA, USA) for 15 minutes at room temperature. After immunofluorescence staining, cells were analyzed by Epics Profile II flow cytometer (Beckman Coulter). Appropriate isotype-matched immunoglobulins (Beckman Coulter) were used as negative controls. The mean fluorescence intensity (MFI) was analyzed for at least 5000 cells per sample [4].

2.5. Statistical Analysis. Statistical analysis was made by using SPSS for windows 11.0. Continuous variables were expressed as mean ± SD and categorical variables were expressed as percentage. Comparison of the expression levels of activation markers on mDCs among the groups was performed using one-way anova test. Tukey HSD multivariate analysis was used to determine among which groups the activation marker levels were different. The comparison of categorical variables between the groups were assessed by Fisher's exact or chi-square tests where appropriate. The association between the levels of activation markers and the number of ectasic vessels was calculated by Spearman's rho correlation

Table 1: Clinical and coronary angiographic findings of the study population.

	NCA ($n = 6$)*	CAD ($n = 6$)	CAD + CAE ($n = 6$)
Age (years)	51.1 ± 4.2	51.1 ± 4.5	50.1 ± 4.0
Gender (male/female)	4/2	4/2	4/2
Hypertension	2/6 (33.3%)	2/6 (33.3%)	2/6 (33.3%)
Diabetes mellitus	2/6 (33.3%)	2/6 (33.3%)	2/6 (33.3%)
Hyperlipidemia	3/6 (50%)	3/6 (50%)	3/6 (50%)
Cigarette smoking	4/6 (66.7%)	4/6 (66.7%)	4/6 (66.7%)
CAE distribution			
LAD	—	—	4/6 (66.7%)
Cx	—	—	5/6 (83.3%)
RCA	—	—	4/6 (66.7%)
One vessel	—	—	1/6 (16.7%)
Two vessel	—	—	2/6 (33.3%)
Three vessel	—	—	3/15 (50%)

*Indicates no significant difference between all groups for all parameters; NCA: normal coronary artery; CAD: coronary artery disease; CAE: coronary artery ectasia; LAD: left anterior descending artery; Cx: circumflex artery; RCA: right coronary artery.

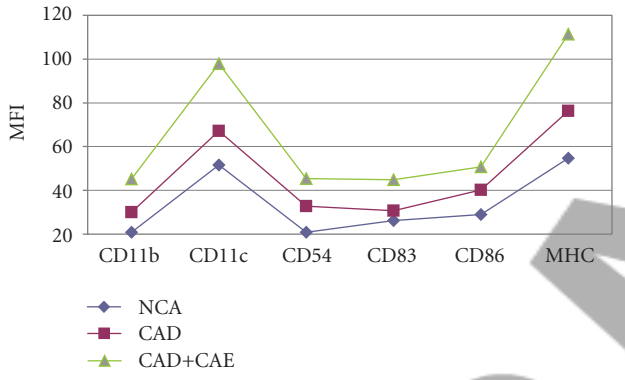

Figure 1: The graphic showing the mean expression levels of the activation markers on monocyte-derived dendritic cells in each study group. NCA: the group with normal coronary arteries. CAD: the group with coronary artery disease. CAD$^+$: the group with coronary artery disease and coronary artery ectasia. MFI: mean fluorescence intensity.

coefficient. A P-value of <.05 was considered statistically significant.

3. Results

There was statistically no significant difference between the groups with respect to age, gender, body mass index, hypertension, diabetes mellitus, cigarette smoking and hyperlipidemia ($P > .05$). The distribution of obstructive CAD was also comparable between CAD patients with or without CAE [single vessel involvement 13.3%, two-vessel involvement 26.7%, and three vessel involvement 60% for both groups] ($P > .05$ for all). The patients in group 1 had diffuse CAE involving the left anterior descending artery in 4 (66.7%), the left circumflex artery in 5 (83.3%) and the right coronary artery in 4 patients (66.7%). One-vessel, two-vessel, and three-vessel ectasia were found to be present in 1 (16.7%), 2 (33.3%), and 3 (50%) patients, respectively. Therefore most of the patients (83.3%) had multivessel CAE. Clinical and coronary angiographic characteristics of the study population were presented in Table 1.

CAD patients with CAE were detected to have significantly higher levels of certain activation markers such as CD11b (44.5 ± 5.0 versus 30.0 ± 3.8 and 20.9 ± 3.6), CD11c, (96.3 ± 10.9 versus 66.1 ± 6.4 and 50.4 ± 5.7) CD54 (45.6 ± 6.7 versus 31.1 ± 4.9 and 20.8 ± 3.2), CD83 (44.6 ± 6.1 versus 30.8 ± 2.4 and 25.6 ± 2.8), CD86 (50.7 ± 5.0 versus 39.2 ± 4.1 and 29.5 ± 4.1) and MHC Class II (112.4 ± 11.3 versus 73.1 ± 9.5 and 54.5 ± 4.5) molecules on the surface of mDCs in comparison to CAD patients without CAE and normal subjects with angiographically normal coronary arteries (Figure 1). MFI of CD14 on mDCs did not significantly differ among Group 1 (13.3 ± 3.1), Group 2 (12.9 ± 2.6), and Group 3 (14 ± 2.9) ($P > .05$). Furthermore we detected a significant positive correlation between the number of the vessels with CAE and the levels of CD11c (Figure 2), CD86 (Figure 3), and MHC Class II molecules (Figure 4).

4. Discussion

The main findings of the present study are (1) the expression of CD11b, CD11c, CD54, CD83, CD86, and MHC Class II molecules in CAD patients with CAE were higher than control subjects with CAD alone and normal coronary arteries; (2) there was a correlation between the levels of CD11c, MHC Class II, CD86, and the number of coronary vessels with CAE. To our knowledge this is the first study that demonstrate the role of mDCs for CAE development in patients with CAD.

CAE has been defined as localized or diffuse nonobstructive lesions of the epicardial coronary arteries with a luminal dilatation exceeding the 1.5 fold of normal adjacent segment or vessel diameter [1]. It has been suggested that the pathogenesis of abdominal aortic aneurysm and CAE is similar that chronic transmural inflammation with destruction

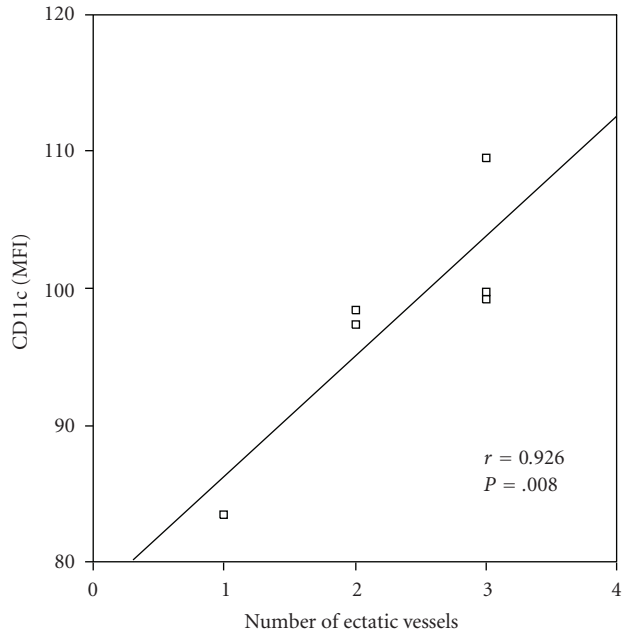

Figure 2: The graph showing the relationship between the number of ectatic vessels and the expression level of CD11c molecule. *r*: Spearman's rho correlation coefficient. MFI: mean fluorescence intensity.

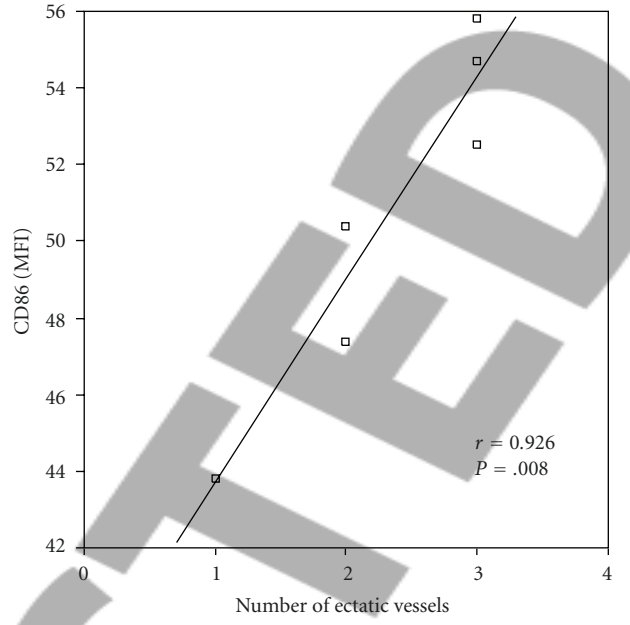

Figure 3: The graph showing the relationship between the number of ectatic vessels and the expression level of CD86 molecule. *r*: Spearman's rho correlation coefficient. MFI: mean fluorescence intensity. MFI: mean fluorescence intensity.

of medial layer of the vessel has a prominent role [2, 14]. Recently we have reported an increase in the plasma levels of tumor necrosis factor-alpha and interleukin-6 in patients with isolated CAE indicating an inflammatory process in the coronary circulation [15]. Furthermore Turhan H et al. showed that levels of soluble CAMs; intercellular adhesion molecule-1, vascular cell adhesion molecule-1 and E-selectin were increased in patients with isolated CAE in comparison to patients with obstructive CAD and suggested that a more extensive vascular wall inflammation may have a role in the development of isolated CAE [16]. Although the role of inflammation was demonstrated in the pathogenesis of CAE, since inflammation takes part both in CAE and atherosclerosis development, it is still not clear why some patients with obstructive CAD develop CAE whereas most do not.

DCs are a component of the proposed vessel-associated lymphoid tissue and are found in the intima and adventitia of susceptible arteries before atherosclerotic lesion development [6, 17]. In atherosclerotic plaques, the number of DCs increase related to the activation of residing intimal DCs and invasion of adventitial DCs to the plaque [6]. Monocytes that infiltrate the intima from the very early stages of atherosclerosis may differentiate into DCs and contribute to an increased DC population as well [6, 13, 18]. Recent findings suggest that DCs play a role in plaque destabilization through activation of T cells [6]. Yilmaz et al. found that up to70% of DCs in the shoulders of vulnerable carotid plaques express increased level of DC activation marker CD83 [9]. Ranjit et al. reported that CD86 was upregulated in patients with unstable angina in comparison to healthy donors [19]. Antigen processing, presentation, and T cell priming efficacy were shown to be maintained in DCs with increased expression of CD11c under hypercholesterolemic

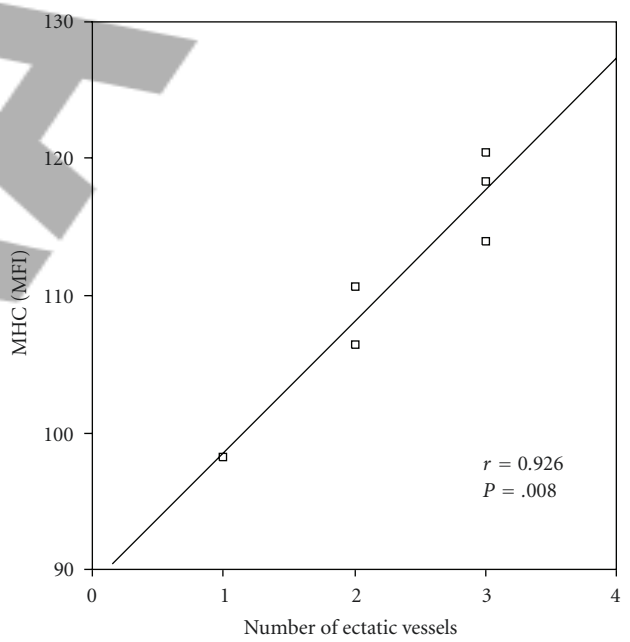

Figure 4: The graph showing the relationship between the number of ectatic vessels and the expression level of MHC Class II. *r*: Spearman's rho correlation coefficient. MFI: mean fluorescence intensity. MFI: mean fluorescence intensity.

conditions associated with atherosclerosis [8]. Although the role of DCs in atherosclerosis were evaluated in various studies, there is limited data about DCs in CAE which has been suggested as a variant of atherosclerosis.

In the present study we have found increased expression of adhesion, costimulatory and antigen presenting molecules on the surface of mDCs in CAD patients with CAE compared to patients with CAD alone as well as normal subjects. Activated DCs have been shown to exhibit large numbers of adhesion molecules such as CD11b, CD54 which contribute to their ability to adhere to injured endothelium, transmigrate and also interact with T lymphocytes [5, 20, 21]. This interaction is accompanied by the increase in the expression of MHC and costimulatory molecules and the production of cytokines leading to their enhanced ability to prime T lymphocytes [4–6]. Therefore increased expression of the surface markers of mDCs with a positive correlation between CD11c, CD86, and MHC Class II molecules and the number of ectasic vessels observed in the present study may support the concept that a more severe and extensive chronic inflammation modulated by DCs takes place in the coronary circulation of CAD patients with CAE in correlation with the widespread involvement of CAE.

Numerous studies have demonstrated that aneurysm tissue contains high levels of matrix metalloproteinases (MMP) which causes degradation of the extracellular matrix leading to weakening and dilatation of the aortic wall [22]. The histopathological examinations of the coronary arteries in small number of cases with CAE were reported to include inflammatory cells in the medial layer comprising chiefly macrophages which were shown to have immunoreactivity against MMP [23, 24]. Recently we reported increased expression of monocyte adhesion molecules in patients with isolated CAE that may be associated with the medial destruction of the vessel wall and CAE formation in agreement with microscopic examinations [12]. Moreover Dogan et al. reported high plasma levels of MMP-3, MMP-9 and interleukin-6 in CAE patients and suggested that inflammation enhanced MMP secretion in the coronary circulation may cause CAE formation [25]. DCs were also shown to secrete MMP to the same extent as macrophages [26, 27]. Hence our finding of significantly increased DC activation in CAD patients with CAE compared to patients with CAD alone may be associated with weakening of the coronary artery wall by MMP of which secretion may be enhanced by DCs.

5. Study Limitations

It is conceivable that the small number of patients limits the power of our observations. The small number of patients in the present study reflects the small incidence of patients with CAE. The phenotypic characteristics of the most mature DCs have been suggested to be complete loss of CD14, and increased expression of CD83, CD86, and MHC Class II receptor [28]. DCs generated by our methods had low expression of CD14, moderate expression of CD83, CD86, and MHC Class II and thus would be considered as relatively immature DCs compared to DCs generated by the other methods [4, 28, 29]. However since mDCs of the three groups were cultivated in the same environment under the same conditions, the significantly different activation marker levels on the surface of mDCs among the groups detected in our study may be of importance. Further studies with larger samples using additional stimulators for improvement of DC maturation which also investigate the correlation between DC activation and MMP secretion are needed to firmly establish our results.

6. Conclusion

The present study indicates that mDCs display an increased cell surface concentration of adhesion, costimulatory, and antigen presentation molecules with respect to their activation in CAD patients with CAE compared to patients with CAD alone and normal subjects. DC activation may play an important role for CAE development in patients with obstructive CAD.

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