Endothelial Dysfunction in Cardiologists After 24 Hours on Call

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The objective was to determine if the stress caused by 24 hours on call in a cardiology emergency room alters endothelial function assessed by high-resolution ultrasonography in the brachial artery.

Fifteen young physicians were studied in a crossover design: *a)* after a normal night of sleep at home, and *b)* after 24 hours on call without sleeping in an emergency room. Both studies were made at rest, 5 minutes after forearm occlusion and 3 minutes after administration of sublingual nitroglycerin. High-resolution ultrasonography and a 7.5-MHz linear array transducer were used to measure the brachial artery lumen.

After 24 hours on call, physicians had significantly higher resting systolic and diastolic blood pressure. They also had a non-significant increase in heart rate and a lower brachial artery diameter. Brachial artery dilatation caused by hyperemia was only 3.35%, while it increased to 11.34% after normal sleep ($p < 0.001$). Only 2 physicians showed more than 4.4% dilatation, which was considered a normal response, while 13 had more than 4.4% after a normal night of sleep at home ($p < 0.01$). The response to nitroglycerin was similar under control conditions and after 24 hours of duty oncall.

In conclusion, stress caused by 24 hours on call in a cardiology emergency room depresses or abolishes endothelial function.

Key words: *Stress. Endothelium. Atherosclerosis.*

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Disfunción endotelial en cardiólogos tras una guardia médica

El objetivo fue explorar si el estrés causado por una guardia médica en el servicio de urgencias de cardiología altera la función endotelial determinada por ultrasonidos en la arteria humeral.

Siguiendo un diseño cruzado se estudió a 15 médicos jóvenes en dos condiciones por la mañana: *a)* después de una jornada habitual de trabajo hospitalario, y *b)* tras una guardia médica de 24 h. Ambos estudios se hicieron en reposo, después de hiperemia postoclusiva de 5 min y tras administrar nitroglicerina sublingual. Para medir el lumen de la arteria humeral se empleó un equipo de ultrasonidos de alta resolución con un transductor de 7,5 MHz.

Después de la guardia, en reposo, hubo una aumento de la presión arterial ($p < 0,05$), así como un incremento de la frecuencia cardíaca y una pequeña disminución del lumen arterial, ambas sin significación estadística. La dilatación por hiperemia, dependiente del endotelio, sólo fue 3,35% mayor que la basal, mientras que después de una jornada habitual, sin insomnio, aumentó hasta un 11,34% ($p < 0,001$). Después de la guardia sólo 2 médicos tuvieron más de un 4,4% de dilatación por hiperemia ($p < 0,01$), mientras que tras condiciones habituales de vida 13 presentaron más del 4,4%. La respuesta a la nitroglicerina (independiente del endotelio) fue semejante en ambos estudios.

En conclusion, el estrés causado por una guardia médica disminuye o suprime transitoriamente la función del endotelio vascular.

Palabras clave: *Estrés. Endotelio. Aterosclerosis.*

INTRODUCTION

Mental stress can cause myocardial ischemia[1,2] and is associated with an increase in cardiovascular morbidity and mortality.[3] In addition, prolonged mental stress stimulates the development of atherosclerotic lesions.[4]

Three studies have used mental stress induced in the laboratory to explore changes in the function of the vascular endothelium, with diverse results.[5-7] Sherwood et al[5] related stress-induced vasoconstriction with impaired endothelial function. Harris et al[6] found an increase in function after carrying out mental arithmetic, whereas Ghiandoni et al[7] reported a decrease in function after an oral public defense related with a supposed crime.

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We proposed to study the effect on endothelial function of being on call for 24 hours.

METHODS

The study included 15 medical residents in cardiology, 6 women, age 27 to 35 years, with no clinical manifestations of cardiovascular disease, who voluntarily agreed to participate. Following a crossover design, two determinations of the endothelial function were made in the humeral artery.[8] one was made at the end of a regular workday and the other after being on call for 24 hours in emergency room. The order of determinations was randomized.

None of the doctors was taking medications or had a recognized cardiovascular risk factor. All were studied between 08:00 a.m. and 09:00 a.m. in a quiet room at 22-24ºC, in fasting conditions and after a 10-minute rest while lying down. The women were between day 6 and 15 of the menstrual cycle and none took contraceptives.

A linear 7.5-MHz transducer was used and a longitudinal image of the humeral artery was obtained before and 1 min after deflating a pressure cuff on the forearm that had been inflated to 300 mm Hg for 5 min. After 10 min, nitroglycerin 400 mg was administered as a sublingual aerosol and the recording procedure was repeated at 3 min post-occlusive dilatation (endothelium-dependent) of more than 4.4% was considered normal with respect to baseline recordings.[9] Post-nitroglycerin dilatation (endothelium-independent) was evaluated in relation to the baseline diameter of the artery.

In each case an average of 5 measurements of the vessel lumen were obtained with an electronic cursor on the end-diastolic image obtained by simultaneously recording an electrocardiogram. In some cases in which was disagreement between three observers, the measurements were corroborated on images enlarged 50 times, taken with a digital camera. The interobserver and intraobserver variability on alternating days was 0.047±0.018 mm and 0.014±0.019 mm, respectively.[9]

For the variables with a normal distribution, the significance of the difference between means was determined using Student t test for independent data. In the case of data derived from the ultrasonographic study, the Wilcoxon non-parametric test for two samples was used. In addition, the post-occlusive increase was compared by means of the ^{2} test, accepting as normal an increment of more than 4.4%.

A value of $P<.05$ was considered significant.

RESULTS

All the data collected and their statistical significance are shown in Table 1.

After 24 hours on call, in baseline conditions, higher values were found for systolic blood pressure ($P<.05$), diastolic blood pressure ($P<.05$), and heart rate (nonsignificant). The arterial lumen diameter was narrower, but not significantly so. All recordings were compared to those made after regular working conditions.

The endothelium-dependent dilatation was significantly smaller after 24-h medical duty compared with that obtained after a normal workday ($P<.01$).

After being on call, 13 doctors did not reach a dilatation of 4.4%, 5 of them did not have any dilatation. In regular working conditions, 13 had more than 4.4%, only 1 did not have dilatation, and 1 4.2% ($P<.001$).

The response to nitroglycerin was similar in both studies.

DISCUSSION

Endothelial function modulates arterial tone and is one of the first preventive barriers against the atherosclerotic process.[10]

The dilatation caused by post-occlusive hyperemia depends on endothelial function and it has been demonstrated that it is depressed or disappears with risk factors for ischemic heart disease.[10,11] Mental stress is recognized as an independent risk factor for atherosclerosis; nonetheless, individual response to different stressor situations varies and the intimate mechanisms that can make this type of stress affect arterial tissue still not known.

The mental stress involved in the three studies in which effect on endothelial function was explored was experimental and of short duration. It is known that this type of stress has less repercussion than that which occurs in regular life conditions.[12] Even so, the depressor effect on endothelium-dependent function lasted almost 4 h in a study in which experimental stress of short duration was induced.[7]

Being on call for 24 hours causes a double stress: stress induced by lack of sleep and stress secondary to

TABLE 1. **Control and post-duty values**

Variable	Control	Post-duty	*P*
Systolic blood pressure, mm Hg	107.3±7.3	112.6±8.4	<.05
Diastolic blood pressure, mm Hg	69.3±7.3	74.3±7.3	<.05
Heart rate, beats/min	69.7±10	72.9±6.5	NS
Baseline humeral diameter, mm	3.67±0.66	3.52±0.53	NS
Post-occlusion humeral diameter	4.12±0.68	3.56±0.56	<.01
Post-NTG humeral diameter	4.32±0.70	4.23±0.63	NS
% of baseline post-occlusion	11.34±7.04	3.35±2.8	<.001
% of baseline post-NTG	18.24±11.43	20.21±6.38	NS

Data shown as mean±standard deviation.

decision-making; in addition, it lasts 24 h.

It is traditionally accepted that mental stress is associated to activation of the sympathetic nervous system[13] and evidence has been found in humans and monkeys that sustained adrenergic activation causes the initiation and progress of atherosclerosis.[14,15] In physicians, the adrenergic influence of being on call can be inferred from the increase in blood pressure and heart rate compared with baseline measurements. However, the reduction or absence of an endothelium-dependent response suggests a direct effect on endothelial function.

It is concluded that the stress generated by 24 hours of duty depresses or suppresses endothelial function.

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