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REGULAR ARTICLE

Changes in blood coagulation of arm and leg veins during a simulated long-haul flight

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Abstract

Introduction: Long-haul flights are associated with an increased incidence for venous thromboembolic events. At present, markers of coagulation and fibrinolysis were only analyzed from arm veins after long distance travel. Respective data from leg veins are missing.
Materials and methods: Here, we measured these parameters in healthy volunteers ($n=12$) before and after 10 h sitting in modern aircraft chairs under normobaric hypoxia (corresponding to 2400 m altitude). Blood was collected from arm and leg veins before, immediately after and 1 day after sitting in the hypoxic chamber.
Results: We did not find any evidence for a significant intravasal thrombin and fibrin formation and a changed fibrinolytic activity, neither in arm nor in leg vein blood. TAT, PAP, and PAI-1 remained unchanged, and the increases of F1+2 in arm veins and of d-dimer in leg veins were within the upper reference limits. Moreover, there was no evidence of activation of coagulation as measured by thrombelastography

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(ROTEM®) and the new Thrombin Dynamic Test at both locations. There was no evidence of arm or leg hemoconcentration.
Conclusions: In healthy volunteers, prolonged sitting in ergonomically superior aircraft seats does not induce significant changes in blood coagulation and fibrinolysis in venous blood of arm or leg. Since this study was performed under moderate hypoxia, reduction in oxygen pressure seems not to be a crucial factor for venous thrombosis at long-haul flights.

Introduction

More than 1.5 billion passengers travel by aircrafts yearly. In the past years several reports suggested a casual link between long-haul flights and thromboembolic events [1—8]. Depending on the study design the range of the incidence of deep vein thrombosis (DVT) and venous thromboembolism (VTE) in aircraft travellers was very wide. Including symptom-free DVT, Scurr et al. [1] reported even a frequency of DVT in the lower limb of up to 10% of long-haul airline passengers. However, in a recent prospective, controlled cohort study Schwarz et al. [4] could demonstrate that long-haul flights of 8 h and longer double the risk for isolated calf muscle venous thrombosis. Flight-associated thrombosis mainly occurs in passengers with pre-existing risk factors for DVT [4,5]. The incidence of pulmonary embolus may be related to flight duration with an incidence of 4.8 per 1 million travellers [2]. It is suggested that prolonged sitting in a cramped position, immobility and compression of the popliteal veins results in venous stasis thus increasing the risk of DVT during long haul flights (for details see [9]). Based on Virchow's triad (endothelial lesion, venous stasis and hypercoagulability), it has been postulated that, besides sitting in a cramped position, DVT may be triggered by aircraft-specific factors, i.e. low humidity, relative hypoxia due to the reduced ambient oxygen pressure and dehydration. Whether these aircraft-specific factors may in fact induce hemostatic changes thus triggering DVT is discussed controversially. Most studies were done under simulated conditions, e.g. hypobaric chamber or before and after a flight, neglecting the whole scenario on board including different stress factors which may be crucial for developing flight-specific health problems. Recently, we measured parameters of hemostasis in 20 healthy passengers during and after a return flight from Vienna to Washington (project "Economy Class Syndrome", ECS [10]). A moderate hypercoagulable state was found as evidenced by thrombelastographic (ROTEM®) measurements, by an increased activity of clotting factors FVII and FVIII and suppressed fibrinolysis. There was no evidence of a pronounced thrombin and fibrin formation. Since it was unclear whether these findings are aircraft-specific or the consequences of seated immobility, we performed a long distance bus travel ("BUS-study"; Innsbruck — Rome, 10 h bus travel) using the same protocol as in the ECS study [11]. Similar to long-haul flights we could demonstrate a certain activation of the coagulation system after a long-distance bus travel in healthy subjects.

In most studies venous blood for measuring parameters of hemostasis was collected from antecubital veins. Hitosugi et al. [12] reported an increased blood viscosity and an increased thrombotic tendency locally in the foot veins but not in arm veins even after 2 h of sitting still. It can not be excluded that there are striking differences in blood coagulation between arm and leg venous blood after prolonged sitting. Therefore, we measured parameters of coagulation and fibrinolysis after 10 h sitting on a modern aircraft chair from blood collected from antecubital veins and veins of the lower limb.

Material and methods

Study design

This project was performed in January 2003. After laboratory screening (routine laboratory analyses and screening for factor V Leiden mutation) 12 healthy participants (9 men, 3 women; mean age = 37 ± 6 years; BMI = 23 ± 3) were included in the study. Written informed consent was given by all participants. The study protocol was approved by the ethics committee of the Medical University of Innsbruck. None of the volunteers had an increased risk for venous thromboembolism according to a recent consensus meeting [13]. Neither one of the participants took medication before and during the study.

All participants remained in a sitting position for 10 h in aircraft seats which were mounted in a