REVIEW ARTICLE

Correlation between the climatic factors and the pathogenesis of deep vein thrombosis

Damnjanović Z[1], Jovanović M[1,2], Stojanović M[2,3]

[1]Vascular Surgery Department, Clinical Centre of Niš
[2]Medical Faculty of Niš
[3]General Surgery Department, Clinical Centre of Niš
Niš, Serbia

Abstract
There are numerous researches dealing with the correlation between the seasons and climatic factors and the pathogenesis of deep vein thrombosis (DVT). The presented researches show an undoubted correlation between the climatic factors and the pathogenesis of DVT. In the majority of researches, retrospection is noted as a disadvantage. Further prospective researches could aim on testing the correlation between both climatic and thrombotics factors and the pathogenesis of DVT. This may additionally clarify the pathophysiological mechanism of the DVT incidence and contribute to the prevention and treatment of risk groups of patients in certain periods of the year. Hippokratia 2013; 17 (3): 203-206

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Corresponding Author: Zoran Damnjanović, Mr sc. med, Clinical Center of Niš, Vascular Surgery Clinic, Bulevar Zorana Đinđića 48, 18000 Niš, Serbia, tel: +38118536353, fax: +381184238770, e-mail: damnjanovicz@yahoo.com

Introduction

There are numerous researches dealing with correlation between the seasons and climatic factors and pathogenesis of deep vein thrombosis (DVT). The published results of the researches differ, which leads to further studies. It is assumed that the obtained results are controversial due to different methodology applied to conduct the researches, as well as to the fact that the influence of climatic factors is geographically dependent.

Correlation between seasons and pathogenesis of DVT

Only a few conducted researches show the absence of correlation between the seasons and pathogenesis of DVT. In Geneva, Bounameaux et al[1] conducted a retrospective study which included 7303 patients registered during the period from 1989 to 1994, with a suspected DVT. The presence of DVT was recorded in each seventh patient out of 300 patients with suspected DVT. The results of their research showed that there was no seasonal or monthly pattern concerning the occurrence of DVT for patients both with suspected and confirmed DVT. A retrospective research conducted by Galle et al, in Belgium[2] during the period from 1982 to 1995, included 512 patients with a diagnosed lower limb DVT, also showed no correlation between the climatic factors and lower limb DVT. In their retrospective research in USA, which included data for a twenty-one-year period, Stein et al[3] showed the absence of the seasonal character of DVT incidence. The absence of a correlation between the seasons and DVT incidence was also shown by Lee et al[4] in a research which included 2774 patients with a diagnosed DVT in 2002 in Taiwan.

On the other hand, studies showing a correlation between the seasons and pathogenesis of DVT are far more numerous. A retrospective research by Boulay et al[5] in France, which included 65081 patients with a diagnosed DVT, showed that the number of patients is far larger in winter than in the summer. The incidence of DVT for patients with protein C or protein S insufficiency was more frequent in the winter[6]. In Austria, Fink et al[7] conducted a research which included 905 patients with a diagnosed lower limb DVT. The research showed a seasonal pattern in the incidence of lower limb DVT, which was significantly more frequent during the cold period of the calendar year (October – March). This study, which observed a correlation between the seasons and the location of lower limb DVT, showed that DVT below the knees was more frequent during the cold period of the year, while DVT above the knees was more frequent during the warm period (April – September).

Manfredini et al[8] conducted a retrospective research which included 2119 patients with a diagnosed DVT, according to the data provided by 25 Italian hospitals, for the period from 2002 to 2004. The results showed that the incidence of DVT followed a rhythmical pattern, with its peak in September and October, and was the most frequent for men aged over 40, patients who had previously suffered a DVT and in immobilized patients. Brown et al[9] conducted

a retrospective research which included 37336 patients with DVT, based on data obtained from Scottish hospitals for a twenty year period. The results proved a seasonal pattern of DVT incidence, with its peak in the winter. Dentali et al[10,11] conducted researches as well as a meta-analysis which confirmed the seasonal character of DVT with its peak during the winter in January. In this meta-analysis, which included about 35,000 patients, 12 studies implied a research on the seasonal variations of DVT, while 10 studies observed monthly variations of DVT.

The study conducted by Jang et al[12] in Korea, included 1495 patients with DVT during the period from 2001 to 2010 and confirmed the seasonal character of DVT with its peak during the winter and in January. A retrospective research on the territory of South Serbia showed a seasonal pattern in the incidence of the idiopathic lower limb DVT with the highest frequency in the cold period of the year (October – March) and the peak in January[13].

There are different explanations for the seasonal character of DVT. An acute, mainly respiratory infection, which is more frequent in the winter, increases the risk for DVT incidence[14]. Infection increases the concentration of fibrinogen, anticardiolipid antibodies and the C protein level, which leads to hypercoagulability that can be the reason for the DVT incidence[15-17]. In this respect, Masoti et al[18] conducted a research which showed a statistically significantly higher level of C reactive protein, D–dimer and the platelets during the winter than in the summer, whereas Keatinge et al[19] showed that the level of fibrinogen and the VII c coagulation factor were higher in the winter than during the summer period. During the cold periods, peripheral vasoconstriction and decreased physical activity may also be one of the reasons for higher frequency of DVT during the winter[7].

Correlation between atmospheric temperature and the pathogenesis of DVT

Cold conditions make changes in the erythrocytes quality and in the number of leucocytes, increase the number of granulocytes and decrease the number of lymphocytes, which indicates the possibility of a potential cause for the development of inflammation and hypercoagulability[20-21].

Exposure to low temperature in the winter period can be a risk factor for DVT incidence[22]. Chung et al[23] conducted a study in 24 centers from 17 countries from Africa, Asia, Europe and South America (including the Caribbean). The study showed that a change of temperature for 5^{o}C was not related to DVT incidence. A research conducted by Brown et al[9] showed that the seasonal pattern in the incidence of DVT was related to the minimum and maximum temperature during a calendar year.

Explanations concerning the effect of temperature on DVT can be found in the results obtained from experimental researches. Marcer et al[24] showed that a short-term exposure to cold performed by healthy volunteers, leads to haemoconcentration caused by the increase in the number of erythrocytes and granulocytes. Kawahara et al[25] reported that exposure to cold conditions performed by healthy volunteers resulted in the increased activity of platelets, being thus a potential factor affecting the pathogenesis of DVT.

Correlation between atmospheric pressure and the pathogenesis of DVT

An experimental study conducted by LaCroix et al[26] showed that the change of atmospheric pressure did not lead to hemostasis disorder. Esquenet et al[27] proved a correlation between atmospheric pressure and DVT. Brown et al[9] reported that each decrease of atmospheric pressure for 10 millibars, nine days before DVT was diagnosed, was related to the increase of the DVT incidence by 2.1%. A retrospective study which included patients from Niš, showed a correlation between the incidence of lower limb DVT and the increase of atmospheric pressure. Each change of atmospheric pressure for 1 millibar on the day of the DVT diagnosis and 7 days before that, was related to the increase of the incidence of lower limb DVT of 5.1%, as well as the increase of the incidence of the above-knee DVT of 5.9%[28].

Correlation between air pollution and the pathogenesis of DVT

Researches dealing with the correlation between air pollution and the incidence of DVT reported the existence of such correlation. Baccarelli et al[29] were the first to study the relation between DVT and air pollution. Compared to the control group, patients with DVT had higher exposure to particles with the aerodynamic diameter of 10 micrometers. The second study conducted by Baccarelli et al[30] showed a correlation between air pollution and DVT in subjects residing near large traffic crossroads. A research conducted in Santiago, Chile[31], showed that the increased concentrations of ozone, sulphordioxide, nitrodioxide and the increased number of particles smaller than or the same size as the size of the aerodynamic diameter of 2.5 micrometers, were related to the increased incidence of DVT.

There are many hypotheses explaining this correlation. A direct effect would be explained by hypercoagulability of vein circulation. An indirect effect of air pollution could be hypothetically explained by the increased number of lung and heart diseases[32,33] which increase the possibility for DVT incidence.

Correlation among rain fall and wind speed with pathogenesis of DVT

Brown et al[9] showed that increased rain fall by 1 mm and increased wind speed by 1 nod, 10 days before diagnosing DVT, caused an increase of the DVT incidence by 0.8% and 0.6% respectively. The authors stated that the mechanisms of correlation between the climatic factors and DVT are so far unknown and deserve further clarification.

The main characteristics of the studies which connect the influence of the climatic factors and the pathogenesis of DVT, are shown in Table 1.

Table 1: The studies which connect the influence of climatic factors and pathogenesis of DTV.

Study	Climatic factors	Geographics areas	Years of study	Number of ` patients	Conclusions
Bounameaux et al.[1]	Seasons	Geneva	1989- 1994	7303	No seasonal or monthly pattern of DVT
Galle et al.[2]	Seasons	Belgium	1982- 1995	512	No seasonal pattern of DVT
Stein et al.[3]	Seasons	USA	1979- 1999	-	No seasonal pattern of DVT
Lee et al.[4]	Seasons	Taiwan	2002	2774	No seasonal pattern of DVT
Boulay et al.[5]	Seasons	France	1995- 1998	65081	Winter pattern of DVT
Fink et al.[7]	Seasons	Austria	1996- 2000	905	Seasonal pattern of DVT related to location of thrombus
Manfredini et al.[8]	Seasons	Italy	2002- 2004	2119	Seasonal pattern of DVT with the peak in September and October
Brown et al.[9]	Seasons	Scottand	1981- 2001	37336	Winter pattern of DVT
Dentali et al.[11]	Seasons	Meta-analysis	-	35000	Winter pattern of DVT
Jang et al.[12]	Seasons	Korea	2001- 2010	1495	Winter pattern of DVT
Damnjanovic et al.[13]	Seasons	South Serbia	2009- 2011	170	Seasonal pattern of DVT related to location of thrombus
Chung et al.[23]	Atmospheric temperature	17 countries	1989- 1995	1146	Change of temperature of 5° C was not related to DVT incidence
Brown et al.[9]	Atmospheric temperature	Scottand	1981- 2001	37336	Incidence of DVT was related to the minimum and maximum temperature
Esquenet et al.[27]	Atmospheric pressure	Italy	1995	345	Correlation between atmospheric pressure and DVT
Brown et al.[9]	Atmospheric pressure	Scottand	1981- 2001	37336	Decrease of atmospheric pressure of 10 millibars related to the increase of DVT incidence
Damnjanovic et al.[28]	Atmospheric pressure	South Serbia	2009- 2011	124	Change of atmospheric pressure of 1 millibar was related to the increase of the incidence of lower limb DVT
Baccarelli et al.[29]	Air pollution	Italy	1995- 2005	870	Relation between DVT and air pollution
Baccarelli et al.[30]	Air pollution	Italy	1995- 2005	663	Relation between DVT and air pollution
Dales et al.[31]	Air pollution	Santiago	2001- 2005	3358	The increased concentrations of ozone, sulphordioxide, nitrodioxide were related to the increased incidence of DVT
Brown et al.[9]	Rain falls	Scottand	1981- 2001	37336	Increased rain fall caused an increase of DVT
Brown et al.[9]	Wind speed	Scottand	1981- 2001	37336	Increased wind speed caused an increase of DVT

DVT: deep vein thrombosis.

Conclusion

The presented researches show a positive correlation between climatic factors and the pathogenesis of DVT. In the majority of the researches, retrospection is a disadvantage. Therefore, further prospective studies should aim on testing the correlation between both the climatic and the thrombotic factors and the pathogenesis of DVT. This would additionally clarify the pathophysiological mechanism of the DVT incidence and contribute to the prevention and treatment of risk groups of patients in various periods of the year.

Conflict of Interest

The authors have no competing interests to declare.

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