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Using Physiological Indices to Consider the Effects of Negative Air Ions on the Human Body

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Abstract: Negative air ions are known to activate cell functions, stabilize the emotional state, and induce recovery from fatigue by preventing acidification of blood and accelerating metabolism. Generators of these negative air ions have recently been incorporated in household appliances such as air-conditioners. However, evaluation of their effects has not been sufficient; there are only a few related reports. In this study, we measured electrodermal activities and the skin blood flow as indices of effects of negative air ions on the autonomic nervous system and cardiovascular system, respectively, by allowing the subject to inhale negative air ions at 7,000 particles/cm^3 or 20,000 particles/cm^3. Although no significant changes were noted in electrodermal activities, our results suggested that negative air ions have effects on physiologic activities including autonomic activities.

Keywords: negative air ions, electrodermal activity (EDA), skin blood flow

1. Introduction

Air-borne molecules charged with a low level of negative electricity are called negative air ions. Negative air ions are known to activate cell functions, stabilize the emotional state, and induce recovery from fatigue by preventing acidification of blood and accelerating metabolism. Generators of negative air ions have recently been incorporated in household appliances such as air-conditioners. However, evaluation of their effects has not been sufficient; there are only a few related reports.[1, 2] In this study, we measured electrodermal activities and the skin blood flow as indices of effects of negative air ions on the autonomic nervous system and cardiovascular system, respectively.

2. Method

The temperature and humidity of a closed room (21 m^2) were adjusted to 26℃ and 60%, respectively. The subject was seated in a chair and a negative air ion generator was placed about 1 m in front of the subject at the height of the nose. The negative air ion concentration was measured using an air-ion counter (KEC-900). The negative air ion generator was adjusted (negative air ion generating air-cleaner Mi Air Clean MIS-05, Serumi Medical Equipment Inc.) to obtain an inhaled negative air ion concentration of 7,000 particles/cm^3 (weak) or 20,000 particles/cm^3 (strong).

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The following 3 experimental conditions were established: (1) 40-minute breathing with addition of no negative air ions, (2) 10-minute breathing with no addition of negative air ions and 30-minute inhalation of negative air ions (weak), and (3) 10-minute breathing with no addition of negative air ions and 30-minute inhalation of negative air ions (strong).

The skin potential reflex (**SPR**) [3-5] and skin impedance reflex (**SIR**) were measured as indices of autonomic activities. Skin surface type Ag-AgCl electrodes (Nihon Kohden) were attached to sufficiently abraded areas.

The skin blood flow was measured using a laser flowmeter ALF21 (Advance). The sensor of the flowmeter was attached to the central part of the palm side of the distal segment of the left middle finger. Electrodes and sensors were attached to the sites shown in **Fig. 1**. **SPR**, **SIR**, and skin blood flow were recorded simultaneously and continuously using a Teac DR-C1 PC Card Recorder. The left hand was rested on the desk during the measurements, and light music was played in the room from the beginning of the measurements to relax the subject.

3. Results and Discussions

Figures 2-7 and **Tables 1** and **2** show the results of measurements in the same subject. The number of appearance time of **SPR** under the 3 conditions showed the following characteristics (**Figs. 2-4**, **Table 1**).

(1) When the subject breathed with no addition of negative air ions for 40 minutes, the appearance time of **SPR** decreased with time.
(2) When the subject breathed with no addition of nega-

tive air ions for 10 minutes and inhaled negative air ions (weak) for 30 minutes, the appearance time of **SPR** decreased with time at first but began to increase 10 minutes after the beginning of negative air ion inhalation.

(3) When the subject breathed with no addition of negative air ions for 10 minutes and inhaled negative air ions (strong) for 30 minutes, the appearance time of **SPR** increased with time.

The subject did not inhale negative air ions (control state) during the first 10 minutes under all 3 conditions. When the subject was only listening to light music, the appearance time of **SPR** decreased with time to about half the control level after 30 minutes. However, when the subject inhaled negative air ions, the appearance time of **SPR** became similar to or higher than the control level after 30 minutes, and the appearance time of **SPR** increased with the negative air ion concentration. These results suggest that negative air ions exerted some effects on the autonomic nervous system as a constant stimulus.

The skin blood flow decreased slightly with time during breathing with no addition of negative air ions and increased slightly after the beginning of negative air ion inhalation, but neither of the changes was significant (**Figs. 5-7, Table 2**).

In our daily environment, the negative air ion concentration is 100-500 particles/cm^3, and the negative air ion concentrations used in this study were comparable to those near a fountain or a waterfall. No unpleasant smell such as the odor of ozone was noted in the generation of negative air ions, and no perceived change in the physical condition associated with negative air ion inhalation was observed.

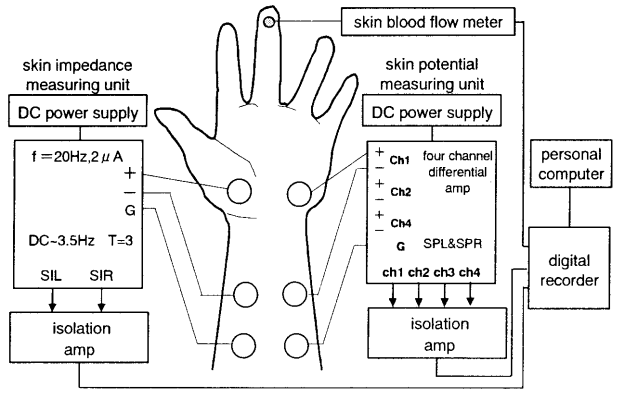

Fig.1 Schematic of the measurement system.

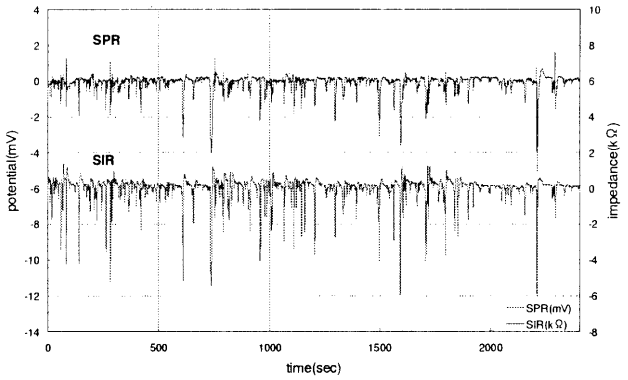

Fig.2 Serial changes in SPR and SIR without addition of negative air ions. The subject did not inhale negative air ions.

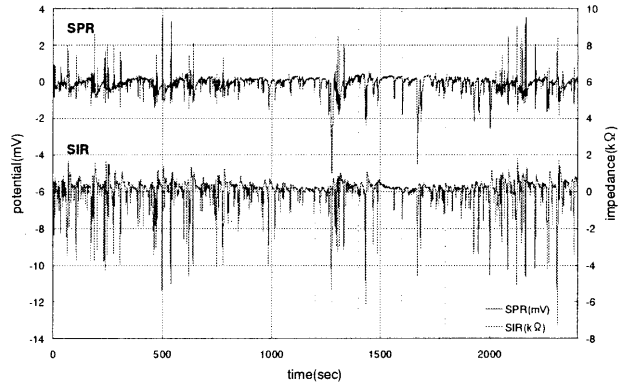

Fig.3 Serial changes in SPR and SIR with inhalation of negative air ions (weak). The subject did not inhale negative air ions during the first 10 minutes and then inhaled negative air ions (weak) for 30 minutes.

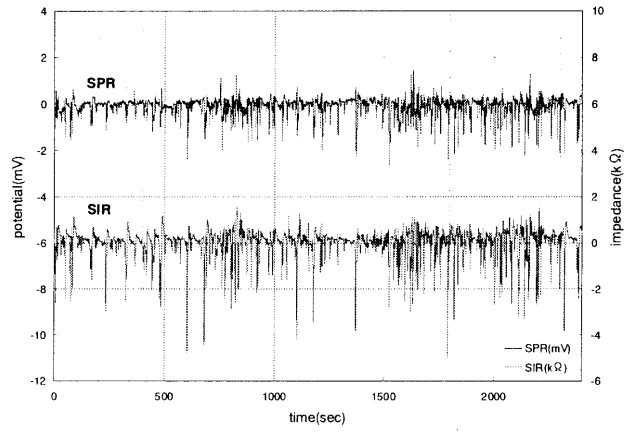

Fig.4 Serial changes in SPR and SIR with inhalation of negative air ions (strong). The subject did not inhale negative air ions during the first 10 minutes and then inhaled negative air ions (strong) for 30 minutes.

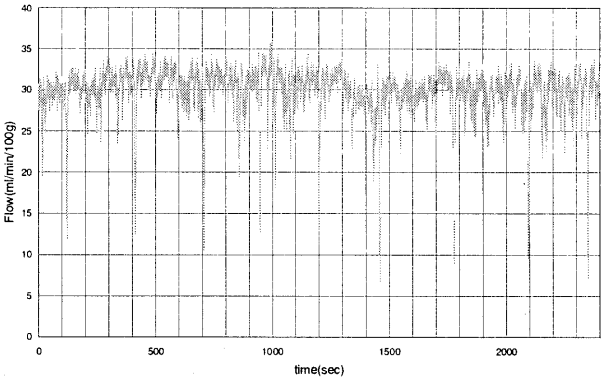

Fig.5 Serial changes in the skin blood flow without negative air ion inhalation.

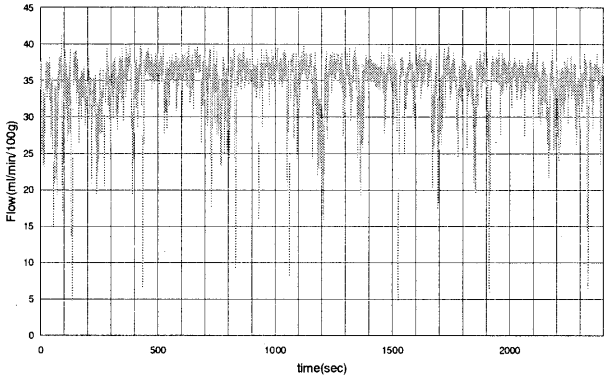

Fig.6 Serial changes in the skin blood flow with negative air ion inhalation (weak).

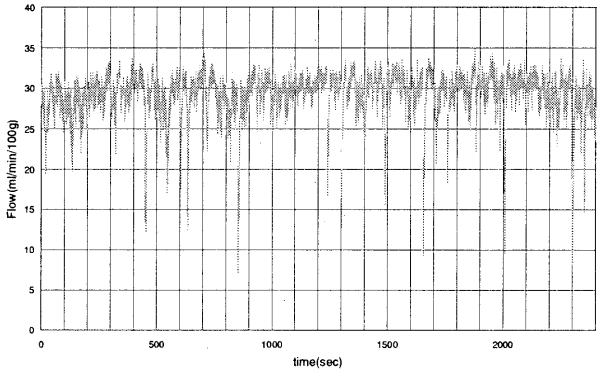

Fig.7 Serial changes in the skin blood flow with negative air ion inhalation (strong).

4. Conclusion

Although inhalation of negative air ions caused no significant change in the skin blood flow, characteristic changes were observed in electrodermal activities. Therefore, negative air ions are considered to affect physiologic activities including autonomic activities.

Table 1 Changes in the appearance time of SPR with time under various negative air ion inhalation conditions.

period / Ion conditions	0-10	10-20	20-30	30-40
without addition	46 (100.0%)	36 (78.3%)	33 (71.7%)	16 (34.8%)
weak	43 (100.0%)	34 (79.1%)	37 (86.0%)	43 (100.0%)
strong	45 (100.0%)	63 (140.0%)	62 (137.8%)	73 (162.2%)

Table 2 Changes in the skin blood flow (ml/min/100 g) with time under various negative air ion inhalation conditions.

period / Ion conditions	0-10	10-20	20-30	30-40
without addition	30.3 (100.0%)	30.4 (100.2%)	29.3 (96.7%)	29.5 (97.1%)
weak	33.6 (100.0%)	34.8 (103.4%)	34.6 (103.0%)	34.2 (101.8%)
strong	28.9 (100.0%)	29.2 (101.1%)	29.6 (102.5%)	29.4 (101.8%)

Notes

1. Electrodermal activities

Electrodermal activities are activities of sweat glands under sympathetic control measured as changes in electric potentials for the assessment of the emotional state of the subject. Electrodermal activities can be classified into skin impedance changes (**SIC**) and skin potential activities (**SPA**). The observed waveforms can be discriminated as skin impedance level (**SIL**), skin potential level (**SPL**), and, as responses of the skin to stimulation, skin impedance reflex (**SIR**) and skin potential reflex (**SPR**).

2. Skin blood flow

Laser beams generated by a semiconductor laser system are applied to the skin surface, and changes in the blood flow of capillaries, arterioles, and venules about 1 mm under the skin surface are expressed as the tissue blood flow.

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生理活動指標を用いたマイナスイオンの身体への作用の検討

(Using Physiological Indices to Consider the Effects of Negative Air Ions on the Human Body)

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要旨：マイナスイオンの身体への作用としては血液の酸性化を防ぎ、新陳代謝を高めることにより細胞機能の活性化、精神安定、疲労回復などが促されることが知られており、エアコンなどに組込みが行われている。これらの作用について科学的、定量的に検討された報告例がいくつかあるものの十分ではない。このため、本研究では被験者への吸入濃度を7,000個/cm^3あるいは20,000個/cm^3に調整したマイナスイオンによる自律神経系と循環器系への作用について、それぞれ皮膚電気活動と皮膚血流量を指標に測定した。その結果、皮膚血流量には有意な変化は見られなかったが、皮膚電気活動には有意な変化が認められた。これより、マイナスイオンが少なくとも自律神経系などの生理活動に作用していることが確認できた。

Keywords: negative air ions, electrodermal activity, skin blood flow

1. はじめに

マイナスイオンの身体への作用としては血液の酸性化を防ぎ、新陳代謝を高めることにより細胞機能の活性化、精神安定、疲労回復などが促されることが知られており、エアコンなどに組込みが行われている。これらの作用について科学的、定量的に検討された報告例[1),2)]がいくつかあるものの十分ではない。このため、本研究ではマイナスイオンによる自律神経系と循環器系への作用について、それぞれ皮膚電気活動と皮膚血流量を指標に測定した。

2. 方法

閉鎖された居室(21m^2)内の環境を空調設備により室温26℃、湿度 60%に設定した。被験者の体位は椅座位とし、マイナスイオン発生器は被験者の前方 1mの鼻の高さに設置した。マイナスイオン濃度測定にエアーイオンカウンター(KEC-900)を用いた。吸入マイナスイオン濃度を 7,000 個/cm^3(弱)、20,000 個/cm^3(強)にそれぞれなるようマイナスイオン発生器(マイナスイオン発生空気清浄機 Mi エアクリーン MIS-05、セルミ医療器械株式会社製)を用い調整し分類した。

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吸入条件は、①マイナスイオン添加無し 40 分間、②マイナスイオン添加無し 10 分間とマイナスイオン(弱)30 分間、および③マイナスイオン添加無し 10 分間とマイナスイオン(強)30 分間の 3 種類とした。

自律神経系の指標として皮膚電位反射(SPR)[3),4),5)]および皮膚インピーダンス反射(SIR)を測定した。その際、皮膚表面型 Ag-AgCl(日本光電製)電極を使用し、電位電極装着部位の剥離は十分に行った。

また、皮膚血流量はレーザー血流計 ALF21(アドバンス社製)により測定した。血流計センサーは左手中指末節指腹中央部に装着した。電極配置および皮膚血流計装着部位は図1の通りである。SPR、SIR および皮膚血流量は、TEAC DR-C1 PC カードレコーダーを用い同時連続測定した。机上に左手を置き安静を図るとともに、BGM として同一軽音楽を測定開始から被験者に聴取させた。

3. 結果と考察

3 条件下での同一被験者の SPR 出現回数には次の特徴があった(図2、図3、図4、表1)。

①マイナスイオン添加無し 40 分間の状態では時間の経過とともに減少した。

②マイナスイオン添加無し 10 分間とマイナスイオン(弱)30 分間の状態では時間の経過とともに当初は減少したが、マイナスイオン吸入後 10 分経過すると SPR 出現回数が増加し

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た。

③マイナスイオン添加無し 10 分間とマイナスイオン(強)30 分間の状態では時間の経過とともに増加した。

実験開始から 10 分間は 3 条件ともにマイナスイオンを吸入していない状態(対照)である。SPR 出現回数は音楽聴取だけでは時間の経過とともに減少し 30 分後では対照と比較して半減した。一方、マイナスイオン吸入により SPR 出現回数は30分後には対照と比較し同じレベルもしくは増加した。これより、マイナスイオンの吸入量の多い状態の方がSPR出現回数は多いことがわかった。これらの所見からマイナスイオンは自律神経系に恒常的刺激として何らかの作用を及ぼしたことが考えられた。

皮膚血流量はマイナスイオンの添加吸入の無い状態では時間の経過とともに少し減少し、マイナスイオンの吸入によりわずかに増加したが、いずれも有意な変化は認められなかった(図 5、図 6、図7、表 2)。

マイナスイオン濃度は日常の生活環境の空気中では 100－500 個／cm^3であり、本実験の場合では噴水や滝の周辺とほぼ同じ量であった。また、マイナスイオン発生時のオゾン臭など不快な臭いは感じなかったし、マイナスイオン吸入による自覚症状の変化もなかった。

4.結論

マイナスイオン吸入により皮膚血流量には有意な変化は見られなかったが、皮膚電気活動には特色のある変化が認められた。これより、少なくとも自律神経系などの生理活動にマイナスイオンが作用していることが確認できた。

注)

1.皮膚電気活動

皮膚電気活動は交感神経支配下の汗腺活動を電気的に測定し、被験者の情動状態を評価する方法である。皮膚インピーダンス変化(SIC)と皮膚電位活動(SPA)に分類できる。測定された波形は、皮膚インピーダンス水準(SIL)、皮膚電位水準(SPL)、刺激に対応する反応の皮膚インピーダンス反射(SIR)、および皮膚電位反射(SPR)に区別される。

2.皮膚血流量

半導体レーザから発したレーザ光を皮膚表面に照射し、皮膚表面下1mm 程度の毛細血管や細動脈、細静脈の血管に流れる血液変化を組織血流量として表わしたもの。

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(Fig. 1-7 英文頁参照。)

(Table 1, 2 英文頁参照。)