Is electrostatic discharge produced under office working conditions in such a way that it can trigger lipoatrophia semicircularis?

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1. INTRODUCTION

Literature suggests that lipoatrophia semicircularis (Ls: semicircular zone of atrophy of the subcutaneous fatty tissue located mostly on the legs) might be produced by electrostatic discharges (ESD) [1 – 3]. Though ESD can be associated with strong electric (E-field) and magnetic (H-field) fields [4] which are able to damage electronic components, up to now there are no data indicating that one of both fields might damage human tissue or that they could trigger bio-mechanisms resulting in Ls. Anyway, the most important lack in the suggested ESD-Ls relation is that never has been investigated if ESD might be generated by the tribo-electricity when man is working at his office desk or get up from his chair. Moreover, no studies have been performed if there exists a possibility of current transfer from tabletop to thigh by contact between both. The present abstract summarizes the results of this investigation.

2. MATERIAL AND METHOD

All tests were performed in the VITO laboratories on 4 office tables and chairs delivered by the KBC bank. In a first step a series of positive control tests were performed by charging the desk tables according to the EN-61000-4-2 [5]. In a second step tests were performed under similar conditions but by charging the tables by tribo-electricity in the way it happens under normal office working conditions. All chairs were charged by tribo-electricity under normal working conditions. Once the tables were charged E- and H-field of the ESD-event were measured by means of electric (HZ530-E) and magnetic field (HZ530-M) probes (HAMEG Instrument) respectively connected to an oscilloscope (Tektronix TDS

3052). The surface voltage of the test furniture was recorded by means of a JCI 140F meter which was connected via the power-multi meter to a laptop.

3. RESULTS

3.1. Voltage leakage of the tables by contact with human body limbs

When the tabletops were charged with the ESD-gun from about 1.2 kV tot 1.6 kV, the surface voltage decrease (SVD) of the tabletop was recorded with JCI 140F (fixed 10 cm above the tabletop) under the following test conditions:

- Test 1: spontaneous SVD without any contact with the tabletop or table frame
- Test 2: SVD by placing one hand on the tabletop
- Test 3: SVD by touching the tabletop with the grounding pin
- Test 4: SVD in normal working position: arms and hands on tabletop and legs without contact under tabletop
- Test 5&6: SVD by touching the border of the tabletop with covered (test 5) and uncovered (test 6) thigh respectively (only curve of test 6 can be seen)
- Test 7: SVD without any contact and legs in normal position under the tabletop

Figure 1 summarizes the results of these tests.

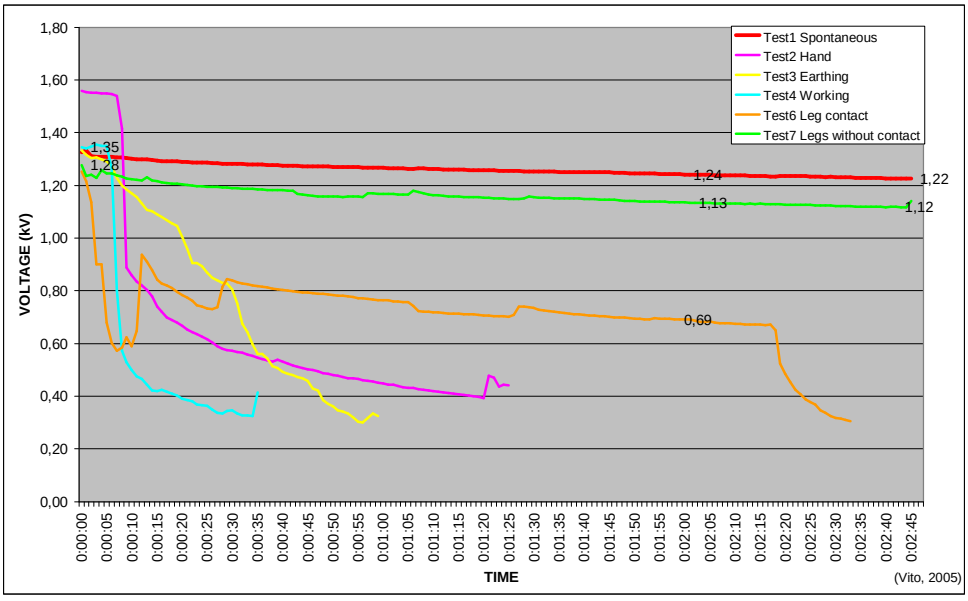

Figure 1. Surface voltage decrease of table #1(BB) under different test conditions

The test 1 (red curve) shows that the spontaneous surface voltage of the tabletop decreases very slowly, and that placing the thighs under the tabletop without any contact (test 7 green curve) the voltage decrease is nearly identical. No current transfer from tabletop via the thighs to the ground will occur in this situation and it would be very surprising that Ls would be triggered by this phenomenon under these working conditions. By placing one hand on the tabletop (test 2, purple curve) a sudden voltage drop occurs which is similar to the one caused by touching the tabletop with a grounded pin (Test3, yellow curve). The same scenario occurs when working with hands and arms on the tabletop (test 4, turquoise curve) and during the contact between the tabletop and the covered and uncovered thighs (test 6, orange curve) respectively. These observations show an accelerated contact voltage loss (it isn't an ESD event) of the tabletop by the transfer of current via the conducting limbs of the human body to the ground. The shape of the curves of the other tables was the same.

Figure 2 shows the voltage decrease when test table #3 was charged up to 250 V by tribo-electricity generated by wiping the tabletop with a cloth during 20 seconds (s).

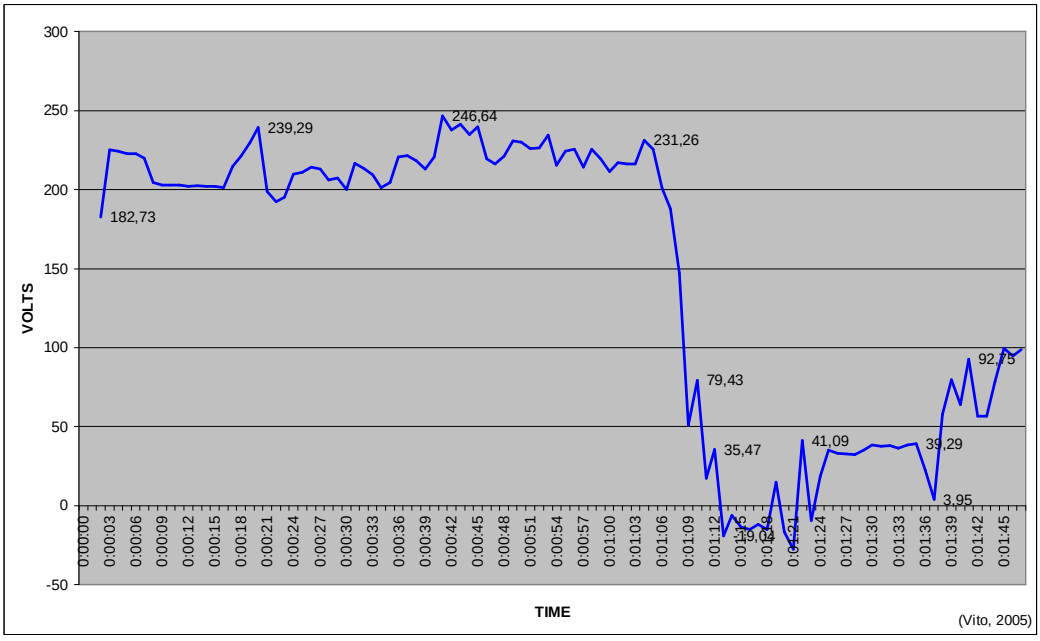

Figure 2. Surface voltage decrease after charging test table #3 by tribo-electricity

When a test person touched the border of the tabletop with his thighs a sudden voltage drop from about 230 V to 0 V occurred. By taking into account the fact that Ls always occurs at the contact point between tabletop and thighs (72 cm high) and since the table may be charged by tribo-electricity and/or by capacitive coupling of cables of computer equipment it is perhaps worth to investigate deeper the hypotheses whether Ls is not related to the current transfer by contact between the border of the table and the thighs.

3.2. Electrostatic Discharge and office tables

Positive control tests

The only ESD-event between **fingertip and table frame** occurred when the fingertip was at a distance of a few millimeters from the bare metal frame of the test table (table #1).

When the was charged under the same conditions and a **grounding pin** was used instead of the fingertip a still stronger E- and H-fields (Fig. 3) was generated. The signal of the H-field has the typical human body shape with a rise time of about 0.7 nanoseconds (ns) and a total signal time of about 60 ns.[6]. The electric and magnetic field strength associated with a human/metal discharge of 5 kV can be 12 kV/m and 30 A/m respectively at a distance of 0.1 m.

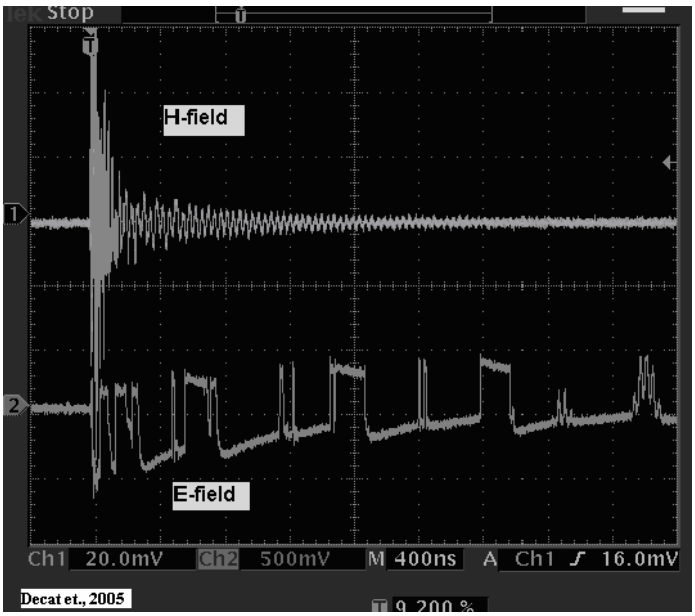

Figure3. E- and H-field of the ESD-event produced between the grounding pin and the bare metal frame of test table #1

Conditions under which ESD was not produced

When the tabletops of the test tables were charged according to the EN 61000-4-2 standard, no ESD-event occurred between:

- fingertip and tabletop of any tested table (TT)
- fingertip and coated frame of any TT
- thighs or knees and the tabletop of any TT
- thighs or knees and the frame of any TT
- thighs under the tabletop but without any contact with the tabletop or the frame

In general we can state that ESD couldn't be produced between any part of the body and any part of the tables of which the frames are coated with an insulating protective material. Since al the office desk are coated and their wooden tabletops act like insulators ($\rho > 10^{11}$ Ω/m/mm²)[12], it is hard to believe that ESD would be produced by tribo-electricity at the thigh level (72 cm high) where Ls occurs.

3.3. Electrostatic Discharge and office chairs

When a test person got up after having moved slightly in his chair during 15 seconds the same ESD event as shown in figure 3 was produced. However, this event could only be generated by one (#1) of the four tested chairs and moreover its irradiation plane is in the back of the thighs while Ls occurs in the front of the thighs. Thus, it is un-expectable that Ls should be triggered by the ESD event of some types of office chairs.

4. CONCLUSION

The positive control tests showed that the electric and magnetic field strengths associated with an ESD-event are easily to record. However, under office conditions ESD can only be produced when there is a voltage difference between two conductors such as for example the bare metal of a table frame and the human fingertip. It cannot be produced between the wooden tabletop (insulator) and the fingertip or any other part of the human body. Since ESD cannot be produced between thighs and tabletop or between the thighs and the coated table frames even when their surface voltage is much higher than can be produced in a natural way by tribo-electricity, the hypothesis that Ls might be associated ESD has to be rejected. It isn't excluded that some biological mechanism resulting in Ls might be triggered by a current transfer during the contact between the border of a charged tabletop and the thighs. However, this hypothesis should be investigated on basis of an experimental design which takes into account all the factors that may induce

voltage differences between all elements (inclusive clothing of the employees) of the office work place that may lead to tribo-electricity.

ESD can be generated simply by getting up from some makes of office chairs. However, since the irradiation plane of the E- and H-field is in the back of the thighs while Ls occurs in the front of the thighs we should reject the hypothesis that Ls is associated with chair ESD.

As a general conclusion we can state that Ls isn't triggered by an office ESD event but that there may be a very small probability that it is associated with contact current. This hypothesis should perhaps be verified in future.

References

1. Curvers B. & Maes A., (2003a) Lipoatrophia Semicircularis: a new office disease: 900 cases reported in Belgium, http://www.sfowler.com/esdjournal/LS%20pub%20BBvAg.doc
2. Curvers B. & Maes A., (2003b) Lipoatrophia Semicircularis: a new office disease: 900 cases reported in Belgium. ESD Journal – The ESD & Electrostatics Magazine, http://www.sfowler.com/esdjournal/lipoatrophia.htm
3. Maes A., (2003). Lipoatrophia semicircularis: An Electromagnetic Hypothesis. Electromagnetic Biology and Medicine 22: 183 – 193
4. Jobava R., Pommerenke D., Karkahadze D., et al. (2000) Computer Simulation of ESD from Voluminous Objects Compared to Transient Fields of Humans. IEEE Transactions Electromagnetic Compatibility, Vol. 42, No. 1.
5. European Standard EN 61000-4-2 "Electromagnetic Compatibility (EMC). Part 4: Testing and measurement techniques, Section 2: Electrostatic discharge test – Basic EMC Publication"

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