

***Lipoatrophia semicircularis:* An Electromagnetic Hypothesis**

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ABSTRACT

The medical literature describes *Lipoatrophia semicircularis* (L.s.) as a rare, idiopathic condition characterized by semicircular impressions of the skin, at the front and sides of both thighs. A few years ago, L.s. was diagnosed in hundreds of people, mainly women, among the administrative personnel of two large companies in Belgium. Afterwards, other cases were reported to us in numerous other companies, also in other countries including the Netherlands, France, the United Kingdom, Germany, and Italy. L.s. is thus not as uncommon as previously thought and apparently seems to become an important job-related illness. We investigated the occurrence and cause of *Lipoatrophia semicircularis* by registering all recently known cases and paying particular attention to the working conditions of the persons with L.s. Following the elaboration of a working hypothesis, a number of measures were taken inside offices in an attempt to prevent new cases and/or obtain remissions. Some measurements were also performed with regard to the electromagnetic environment of the workplaces. *Lipoatrophia semicircularis* occurs preferentially in administrative female personnel working in new or renovated office buildings. All afflicted persons work with computers or are at least working in the proximity of electrical devices. It soon became evident that this electric environment plays a major role in the

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occurrence of L.s., although other factors (e.g., inadequate sitting posture and dry ambient air) may further facilitate L.s. According to our observations, L.s. finds its origin in the electromagnetic environment of work places. It apparently occurs as a result of galvanic coupling between charged materials and the body.

Key Words: *Lipoatrophia semicircularis*; Workplace; Electrostatic charging/discharging; Adipocytes.

INTRODUCTION

Lipoatrophia semicircularis (L.s.) is described as a rare idiopathic clinical disorder characterized by semicircular impressions of the skin, due to the disappearance (atrophy) of the subcutaneous fatty tissue. About 70-odd patients are mentioned over the whole of the scientific literature. Skin and underlying muscles remain intact. In most of the cases, the lipoatrophic region is localized at the anterolateral part of both thighs in a symmetrical way (Figure 1). It typically afflicts women (Ayale et al., 1985; De Rie, 1998; Gschwandtner and Münzberger, 1974, 1975; Karavitsas et al., 1981; Nagore et al., 1998).

Until now, the aetiology of L.s. was unknown; the literature is mainly descriptive and as regards aetiology very hypothetical. The cause of L.s. remains so far speculative. Most authors invariably hypothesize local mechanical pressure (microtraumata caused by either repetitive pressure against an object or by wearing tight clothing) as being its origin (Bloch and Runne, 1978; De Groot, 1994; Gruber and Fuller, 2001; Hermans et al., 1999; Hodak et al., 1990; Mascaro and Ferrando, 1983). Recent observations of more than 1500 cases of L.s. clustered mainly in big Belgian administrative companies lead us to question this mechanical hypothesis. If local mechanical



Figure 1. Example of *Lipoatrophia semicircularis*.

pressure is the origin of the problem, there is no reason why presently we have so many cases. A few years ago, there were only a small number of L.s. cases described, although the frequency of mechanical pressure was the same as today. It is rather obvious that a new additional factor is responsible for the recent massive outburst of cases.

CLINICAL OBSERVATIONS

Afflicted People

At a large Belgian bank and insurance company having the highest incidence of L.s., the personal data of the afflicted staff (810 persons, or 5% of the company, with a figure reaching 33% in some services) were recorded. From the data, the following remarkable points emerged:

- The disorder is mainly and almost exclusively afflicting administrative personnel working with computers.
- Nearly 86% (85.9%) of the disorders occur in women, 14.1% in men.
- The pathology is distributed across age groups and follows the employees' age pyramid.
- No link with another medical disorder among the afflicted employees is observed.

Workplace Analysis

L.s. apparently is a typical problem connected to the workplace. It was indeed observed that when the subjects left the office for a certain time (e.g., for maternity leave), the symptoms often ameliorated and sometimes even disappeared. Once back at the office, the symptoms returned.

As was already stressed, the massive outburst of L.s., especially in administrative staff, must be due to a new additional factor to which people are exposed in their working environment. The increasing informatization of administrations is the most striking change of the last years.

In most of the cases, L.s. appeared within about 2 or 3 months after moving to new office buildings or a new working environment equipped with new data cables, new furniture (desks and chairs), and new phones. Most of the computer equipment stayed the same. In a pilot study, measurements of 50-Hz electric and magnetic fields were performed at a number of working places (Decat, 1997). Magnetic fields appeared to be normal (between 0.2 and 2 mG). However, the electric fields under the desks, at knee-level, were higher than the normal background. They differed from one office to another and ranged between 50 and 299 V/m. This is higher than the background level of 2 V/m but still much lower than the Belgian regulation value of 5 kV/m (Ministerial Decree, 20 04 1988).

A very striking fact is the height of the impressions on the thighs: In practically all the cases, the lipoatrophic condition occurs at approximately 72 cm height measured standing up from the floor (with shoes on). This precisely corresponds with the



Table 1. Superficial (horizontal) and transverse (vertical) electric resistance in a number of desks that are currently in use.

	Superficial resistance (Ω)	Transverse resistance (Ω/cm)
Type 1: fiberboard	3.06×10^{11}	7.00×10^{10}
Type 2: fiberboard	1.06×10^{11}	3.45×10^{10}
Type 3: laminate	4.06×10^{11}	5.60×10^{10}
Type 4: thin MDF	1.33×10^{13}	2.20×10^{12}
Type 5: thickMDF	1.90×10^{10}	3.50×10^{12}
Type 6: laminate	4.20×10^{10}	2.80×10^{10}

standard height of the office desks. A few other observations point to the desktop as probably being related to the origin of the problem:

- L.s. often develops within a few weeks after the installation of new desks.
- When L.s. subjects return to work at the old desk that was used before L.s. was diagnosed, a complete recovery was observed in all persons involved.
- Persons switching from one workplace to another (same building, same floor, same job but different desk) contracted L.s. in one workplace, but it disappeared in the other location.
- Electric resistance measurements of the different desktop materials were performed by a specialized laboratory (Laborelec) (Table 1). Measurements of the superficial and transverse resistance were performed in laboratory conditions at $23 \pm 1.5^\circ\text{C}$ and an ambient humidity of $50 \pm 10\%$. The relative humidity in the workplaces was predominantly less than 50% (as low as 38%); this resulted in a real electric resistance even higher than the one measured in the laboratory. It appeared that L.s. was diagnosed in people who worked on tables with higher superficial electric resistance (above 10^{11} and up to 10^{13} Ohm in the laboratory). Desks with a high superficial resistance can be electrostatically charged. The resulting hypothesis therefore is that L.s. results from electrostatic charging of the desktop due to electric leakage from computers, the screen, and/or the cables (e.g., UTP cable for data transmission). Coupling (galvanic or capacitive) with a conductor, in this case a human being, results in a discharge of the table on that local region where the human body is coupled with the edge of the table (thighs at 72 cm measured standing up from the floor). The phenomenon of charging and discharging of materials may even be more serious in those (new) offices where the ambient air is (too) dry due to air conditioning systems.

Occurrence of *Lipoatrophia semicircularis*

This remarkable problem is not limited to this one company with such an amazing amount of L.s. cases. If L.s. is due to the changed modern working conditions, it should also be present in many other companies, not only in Belgium but also in other countries. The medical departments of a selected number of companies (48) in Belgium were consulted. A limited number of them (15) replied to our questionnaire (Table 2).

Table 2. Report from 15 Belgian companies on the occurrence of *Lipoatrophia semicircularis* in their offices and/or workplaces.

Type of business	Number of identified cases	Remarks
1. Scientific research institute	—	
2. Scientific research institute	—	
3. Mining company	—	
4. Airplane manufacturer	—	
5. Car manufacturer	—	
6. Car manufacturer	—	
7. Pharmaceutical company	—	No occurrence at the time of consultation. At present (1 year later) 28 cases were diagnosed among administrative female personnel. All cases were diagnosed after moving into a new building with air conditioning (dry atmosphere) and new furniture. In another building without air conditioning the same furniture was installed, but no cases of L.s. were diagnosed.
8. Pharmaceutical company	—	
9. Wire manufacturer	—	
10. Occupational Medical Service	2	Females using personal computers. L.s. apparently occurred without identified previous changes in working conditions.
11. Hospital	3	Occurrence of L.s. in females after installation of new desks. Improvement of the condition after removal and replacement of desktops.
12. Bank	4	Improvement after lowering the chairs (increasing distance between legs and desks).
13. Governmental institute	9	Occurrence of L.s. in 8 females and 1 male employee after installation of new desks. Returning to the old desks resulted in remission from L.s.
14. Bank	5	Returning to the old desks resulted in remission from L.s. in all 5 female subjects.
15. Bank	15	Improvement of the situation in 60% of the female and male subjects after removing PCs from the main desk.



Table 3. Testimony of subjects who spontaneously reported *Lipoatrophia semicircularis* in their office environment.

Work environment [type of work: invariably administration (computer work)]	Number of companies	Occurrence of L.s.
New or renovated building, office or working floor, usually with new furniture and air conditioning.	14	<ul style="list-style-type: none"> – 7 companies with one female L.s. case – 1 company with two female cases – 1 company with three female cases – 1 company with five female cases – 1 company with seven female cases – 1 company with eight female cases – 2 companies with ten (female + male) cases
New furniture: new desks with desktop in new materials, usually thin and sharp-edged. Often combined with new chairs, installation of air conditioning, new carpets.	22	<ul style="list-style-type: none"> – 7 companies with one female case – 4 companies with two female cases – 2 companies with five female cases – 3 companies with six female cases – 2 companies with seven female cases – 2 companies with eight (female + male) cases – 2 companies with nine (female + male) cases
Moved to another office.	6	<ul style="list-style-type: none"> – 5 companies with one female case – 1 company with ten female cases
Particular cases:		
<ul style="list-style-type: none"> – L.s. developing at only one leg (the one that usually makes the contact with the desk). New desk installed prior to onset of L.s. 	2	<ul style="list-style-type: none"> – 2 companies with one female case
<ul style="list-style-type: none"> – L.s. subjects testify they “feel” electric discharges at the edge of the desk. They consider themselves as hypersensitive to electricity. New workplace, new furniture, and computers in two of the companies. 	3	<ul style="list-style-type: none"> – 3 companies with one female case. In one instance L.s. also occurred at the forearms and belly.

L.s. was also diagnosed in 6 of them (7 at the present). The rather small response (31%) is presumably due to the fact that L.s. is still an unknown phenomenon for many physicians. They simply do not pay attention to it. However, a number of new cases were diagnosed but a much higher response was obtained from spontaneous testimonies of afflicted persons (Table 3). Those replies were not only from Belgium but also from the Netherlands and occasionally also other countries. Most of the involved subjects appeared to have consulted their physicians, who were unable to recognize and accurately cure the affliction. Recent publications also demonstrate the presence of clusters of L.s. in France (Senecal et al., 2000) and the United Kingdom (Gruber and Fuller, 2001) (others are known in Germany and Italy) and these also seem to be related to changes in the workplace, especially new offices equipped with modern-design furniture. Here also L.s. was found at the thighs at a height corresponding to the height of the desktop.

From the testimonies it clearly appeared that the affliction is present in many companies. Tables 2 and 3 show that nearly all the cases occur after the person starts to work on a new desk and only in those subjects working with computers or working in the immediate vicinity of a source of electromagnetic fields. The tables also clearly show that the frequency of L.s. occurrence is highest in women.

DISCUSSION

As mentioned in the introduction, the scientific literature regarding the etiology of L.s. remains very hypothetical. Local mechanical pressure is the most common reason given (Bloch and Runne, 1978; De Groot, 1994; Gruber and Fuller, 2001; Hermans et al., 1999; Hodak et al., 1990; Mascaro and Ferrando, 1983). As examples of this kind of pressure, the authors mention "repeated leaning against the edge of the working table" (De Groot, 1994; Gruber and Fuller, 2001; Hodak et al., 1990) or "wearing tight trousers resulting in a constriction of the thighs" (Mascaro and Ferrando, 1983). However, this cannot adequately explain the outburst of so many cases we are presently and continuously dealing with.

A very rare anatomical variant, in which the arteria circumflexa femoris lateralis originates on the arteria femoralis and not on the arteria profunda femoralis as usual, has also been proposed as an explanation for the occurrence of L.s. (Bloch and Runne, 1978). As a result of this difference in anatomy the arteria circumflexa femoralis lateralis is more distally located, so that at sitting down a pressure is exerted on this artery, giving rise to an ischaemic atrophy on the front of the thigh. From a purely anatomical point of view, an influence on a small part of the thigh seems hardly acceptable, but most significantly this anatomical variant is found to exist in only about 3% of the population. This variant can therefore be responsible for the few cases described until now in literature but not for the present large clusters of L.s.

It is obvious that a change in the living and especially the working environment is causing this massive number of L.s. cases. The informatization of the working environment has brought with it adaptations in the accommodation; furniture (desks and chairs) is adjusted for computer work; new materials have been used. An important factor may also be the use of air conditioning systems introduced in modern offices which leads to a very dry atmosphere.



As already mentioned, the desktops can be differentially charged depending on the material of which they are made. Certain new materials (synthetics) are more electrostatically chargeable than the classic materials (wood), a phenomenon which is even more obvious in a dry atmosphere (air conditioning).

Local electrostatic discharges on that region of the legs, where the human body is coupled with the edge of the table, can in a biologically plausible way explain what is happening in the lipotrophic tissue. From the few available histopathologic observations derived from biopsies, we know that changes in blood vessels, resorption of adipocytes, and the presence of activated, lipid-containing macrophages are some of the described features of L.s. (Dahl et al., 1996; Pibouin et al., 1986; Schnitzler et al., 1980; Zalla et al., 1995). We do not know if the lysosomal active macrophages are the cause or the consequence of the atrophy of the adipocytes.

Activated macrophages produce cytokines, e.g., TNF α that is able to damage adipocytes and modify the amount and structure of adipose tissue (Petruschke and Hauner, 1993; Prins et al., 1997; Zalla et al., 1995). L.s. may find its origin either in the activation of macrophages by an external cause (electric stimulation), followed by a TNF α -induced leakage of adipocytes and internalization of the microdroplets of lipids by the macrophages, or in direct damage of the adipocytes by an external factor (electrostimulation), followed by a mobilization and activation of the macrophages in order to clear away the waste (delipidated damaged adipocytes and free lipid droplets).

Regarding the first pathway, the literature provides some evidence. An electroactivation of macrophages is for example described *in vitro* as well as *in vivo* for different frequencies of electromagnetic fields (Gamaley et al., 1995; Pessina and Aldinucci, 1998; Singh and Bate, 1996). TNF α is furthermore a key ligand in the regulation of many intracellular processes, both physiological and pathological. It has been shown that weak microwaves, and probably also other nonionizing radiation, induce TNF α production in macrophages and T cells of total-body irradiated mice (Fesenko et al., 1999).

It may also be noted that L.s.-afflicted persons did not show increased chromosomal aberrations in their white blood cells (Verschaeve et al., 1997).

Not only were the desks adjusted for computer work, but also new chairs were developed to sit in a comfortable way with special attention for neck and back complaints. It is, however, possible that the adaptations of the chairs have a consequence of compression pressures and push off forces on the back of the thighs producing a reduced blood flow to the anterior side of the thighs (Hermans et al., 1999). It has been proposed that a reduced blood flow can be the cause of L.s., producing a situation similar to the rare congenital anatomical variant mentioned before (Bloch and Runne, 1978). Changing chairs and sitting postures were, however, mostly unsuccessful as a cure of L.s. (see Table 3). It may be possible, however, that compression pressures and push off forces make the fatty tissue more sensitive for other factors inducing this atrophy. Our observations indeed incline us to believe in a multifactorial origin of L.s. rather than just one single cause.

Interindividual differences of (hyper)sensitivity will also have an influence on the occurrence of the L.s. It is indeed observed that a number of people do not develop L.s. although they are working under the same conditions as their afflicted neighbors. The same argument may be valid for the amelioration and disappearance of L.s. Here we also observe interindividual differences in response to changes (improvements) of the working conditions.

Much more women are afflicted by L.s. than men: Based on the records of the highest afflicted company (and also reflected in the other cases summarized in Tables 2 and 3), 85% of the cases occur in women. This can be explained by the difference in fat tissue structure, as the superficial fat layer on the thighs is much looser in women (Lacotte et al., 1994). This probably makes it more sensitive for the development of L.s. Men are not spared from it but the frequency is much lower and the phenomenon apparently develops after a longer period of time.

Finally, it should be stressed that preadipocytes remain present at the lipotrophic sites and hence that new adipocytes may be formed and a complete recovery remains possible (Atlan-Gepner et al., 1996). This was indeed observed in many cases, e.g., disappearance of the symptoms when the work environment was left for at least a couple of weeks. Also spontaneous recovery was observed from time to time.

CONCLUSION

Although this "disease" is catalogued as a very rare one, it is now occurring very frequently at least in certain workplaces. The statement of rarity is really not true anymore. We may conclude from our observations that the now-frequent occurrence of *Lipoatrophia semicircularis* is directly related to modern working conditions. The solution as well as the cause is most probably a multifactorial one in which the electromagnetic aspect plays an important role.

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