

Thermal Injuries from Laptop Use: Investigating Effects on Cartilage, Genital, and Dermal Tissues - A Call for Expanded Research

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Abstract: ***Objective:** To highlight the noticeable thermal effects of laptops on not only dermal tissues and genitals but also joint cartilage, as well as the long - term negative effects. **Materials and Methods:** A study was conducted on 225 patients in the KRUSHI Orthopaedic Welfare Society Research wing, and the data was analysed with their consent (2020 - 2024). Various other databases like PubMed and others were also searched, and to our surprise, we found that the research done on this daily workplace and home - based hazard has not been researched enough yet since 2002: Ito A. et al. (2014) the latest reference on this topic. [1] as per our records. **Results:** In our study, we recorded 41 degrees temperature, and in the literature, 62 degrees have been reached on the surface of our laptops, which affects the scrotal temperature, degrading the sperm quality and fertility due to DNA fragmentation along with electromagnetic fields and the Wi - Fi radiation. In expected mothers, the EMF generated passes directly from the mother's tissues to the growing foetus. **Discussions:** Erythema ab igne (EAI) is a thermal burn seen as reticulated erythema and hyperpigmentation and may even cause second or third - degree burns. Our study has shown that the temperature record goes up as high as 39.6 degrees Celsius. This means a core temperature of +1 adding up to 39.6+1.0=40.6 or rounding off to 41 degrees Celsius or 105.8°F. The reason could be obstructed ventilation, hardware malfunction, prolonged usage, or contact areas changing with posture, resulting in heat build - up in the laptop. Our study reported patients with increasing wrist pain, fatigue, redness or erythema, which makes it necessary for an immediate larger population study to understand the slow thermal energy - induced degenerative effects on the human cartilage as animal and mammalian studies have shown cell arrest at 42 degrees Celsius. Precautions include the use of protective gear, insulating covers, cooling techniques, and short breaks when the work is hectic from the laptop. **Conclusions:** Pain, redness, and mild stiffness in the wrist region diminished when laptop usage was discontinued for 3 - 4 days, indicating a transient adverse effect. The permanent sequelae need to be studied in human cartilage models as the user group today has young children with immature bones using laptops for online studies.*

Keywords: Erythema ab igne, Thermal burns, Cartilage damage, TUNEL - positive cells, Articular Chondrocyte Metabolism

1. Introduction

To highlight the dangers of prolonged usage of laptops with close body contact for office and extended office hours, which may be the cause of unilateral wrist pain, which is reversible pain at first but leads to wrist cartilage damage, skin damage and radiation to the growing foetus, impaired spermatogenesis and other serious occupational or recreational health hazards. [more studies are needed].

Objective: The objective of this article is to show the reader that laptops can have a negative role if not used safely and surprisingly, there are very few research articles.

Aetiology: The source of heat is infrared and electromagnetic radiation. [19].

LC emissions are complex waveforms generated by the main AC power supply and by the sub - system's display power supply.

The magnetic flux density has two components

- 1) Field amplitude,
- 2) weighted peak (WP) index.

There are models specific to higher emitting radiation. A study using numerical dosimetry techniques, current density, and in - situ electric fields was conducted and studied using

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the Scalar Potential Finite Difference (SPFD) numerical method in a Quasi - Static scenario, and the electromagnetic

dosimetry was evaluated for electromagnetic dosimetry in quasi - static conditions.



Figure 1: Shows an, image of the Employers are providing Laptops which cause both thermal injury and other postural orthopaedic complaints on the long run due to abnormal postures.

Pathophysiology:

Electromagnetic fields (EMF) create induced currents found to be in the range of 1.8 - 6 μT and these cause magnetic flux to the user or to the foetus in the womb when the laptop is used for prolonged hours. This range is considered within the values recommended by NIR & ICNIRP guidelines - as per the MPR II & TCO, this range of 1.8 - 6 μT EMF is considered high and considered risky for Tumour development.

Laptops send out two energies:

- 1) LTC - induced currents are within the normal recommendations set by the ICNIRP [within 34.2% to 49.8%]. This range is not negligible.
- 2) The Laptop with the power cord connected induces strong intracorporal electric current densities of 182 - 263% & 71 - 483% higher than that recommended by the ICNIRP to prevent hazards to the user's health.

As per VOSS, et al (2006), The viability of the chondrocytes to thermal energy was studied, and the following was the conclusion:

At 37 degrees temperature, chondrocyte viability differs in each of the four layers of the cartilage calculated as the mean \pm SEM percentage:

- A) Layer 1: $76 \pm 3.5\%$;
- B) Layer 2: $79 \pm 3.4\%$;
- C) Layer 3: $62 \pm 6.1\%$;
- D) Layer 4: $50 \pm 6.2\%$.

They found the percentage of viable cells to decrease for each increase in temperature higher than 45°C, and when the temperatures increased from 50° to 55°C, the largest decrease in viability was noticed.

Treatment:

- 1) The initial clinical features of redness, burning, pain, and discomfort disappear with avoidance of the Lap top usage

for a few hours to a few days, but if it is used for more prolonged hours, then slowly, as per the animal and mammalian studies slow changes of degradation of the dermis, cartilage and the synovial tissue will ensue as the temperature raises with non - stop usage with raising radiations.

- 2) Prevention is better than cure - which in our view is "PREVENTIVE ORTHOPEDICS" by using wrist soft padding, gloves with padding, and lap blankets.
- 3) Switching over to a desktop with a larger monitor for better cervical posturing and better distance away from the source of the continuous radiations. {Today, till some great innovation comes in when laptops are discarded...Laptops are very much a part of our daily routine}.

2. Discussion

Research of our own case studies in Krushi O W S research wing and review of the Physical Findings and Images from various publications:

In this antegrade study of our patient's volume of 225 in Krushi Orthopaedic Welfare Society & retrograde survey of a few published reports, our findings reveal that the most suitable temperature clinically to work with laptops was at 37 degrees and variations cause discomfort in the contact areas with the laptop...and a retrograde study of the research articles themed on thermal injury revealed that "Cell proliferation was more at 37°C than at 32°C and 41°C" [1]



Figure 2: Shows the laptop temperature at 33.5 degrees Celsius at 19: 00 hours. This picture is from a study done in the Krushi O W S research unit.



Figure 3: Shows the laptop temperature at 37.8 degrees Celsius at 19: 20 hours.



Figure 4: shows the laptop temperature at 39.6 degrees Celsius at 19: 58 hours, equivalent to 41 degrees Celsius [when the core temperature of 1 degree is added after one hour of usage].

In most of the research articles, findings are mostly from the sheep and pig cartilage and only sparse research on mammalian cartilage models, raising an important alert that more studies must be done on human cadaveric models urgently as this paucity of research on human cartilage models will give false sense of security to the human lap top user as then we are blinded to how laptop generated heat causes slow and chronic cartilage degeneration from mild damage. The references given below are a testimony of how sparse the research on this important topic is:

It was observed that there is a reduction of cartilage growth at low temperatures due to a lower metabolic rate and expression of cold shock response genes [2].

The most suitable body temperature for cell growth is 37 degrees.

In research on cell death, acute reactions caused by heat stimuli have been well - studied [3.4].

At temperatures from 32 - 41°C, chondrocytes may not experience cell death, even if exposed for a long period of time. The final stage of cell death is seen as the appearance of tunnel - positive cells, which are DNA - fragmented cells in a stage of APOPTOSIS, confirmed in a TUNEL assay or a TUNEL deoxynucleotidyl transferase dUTP nick - labelling assay.

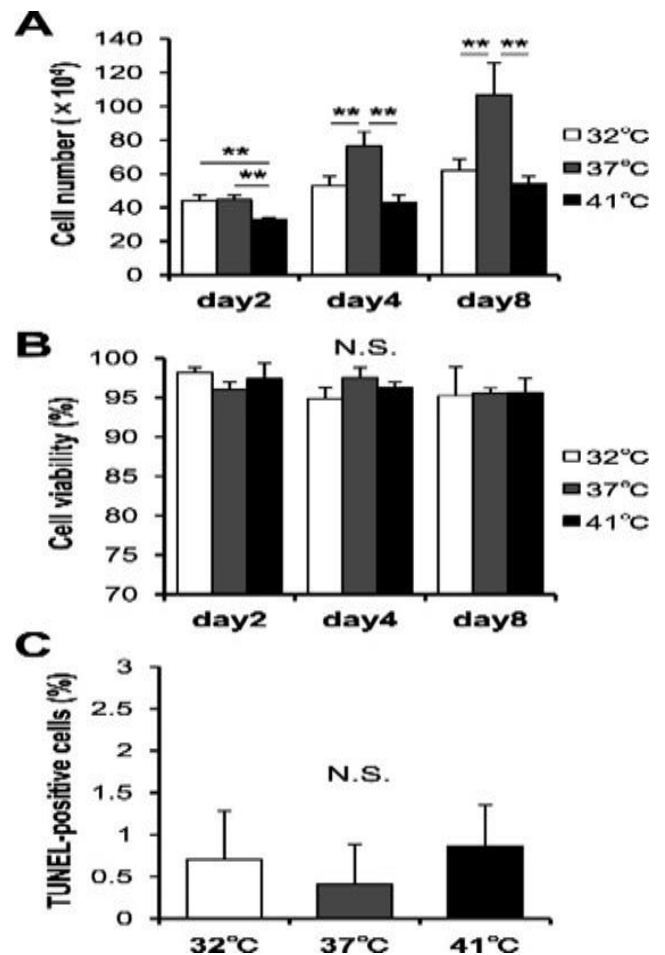


Figure 5: shows a comparison chart of how the cell number in chart A, cell viability in chart B, and Tunel positive cells in chart C vary with temperature elevation (least cell death is seen at 37 degrees Celsius. [1])

Tunel - positive cells are DNA - damaged cells as identified by Tunel assay or Tunel where DNA fragmentation is seen leading to apoptosis, considered the final stage of cell death. The proportion of TUNEL - positive cells on Day 3 was also low at < 1% of the total cells (Fig 4) [1].

Cartilage - protective factors and degradative factors are present.

TIMP1 and TIMP2 proteins are cartilage - protective factors that combine with MMP proteins like MMP13, which are cartilage degradative factors of type II collagen protein and

result in upgradation in a temperature - dependent manner inactivating the function of the MMP Proteins [5].

In the study, as per an article by Li, Wen H. et al. the relative amounts of the MMP & TIMP proteins were assessed at the mRNA level in their study but not at the protein level (6)

In Human Skin, Fibroblasts and epidermal Keratocytes - when thermal energy is applied, in the MMP1 proteins, there is more mRNA expression, and it is upregulated (7, 8)

When thermal stress is applied, the denatured proteins in the cytosol are reactivated by the Chaperon proteins HSP70 into better - activated states to restore Haemostasis (9).

More studies have to be done on human cartilage tissue as the effects of the thermal environment on the MMP1 mRNA expression differs depending on the cell species as enhanced chondrocyte anabolism due to thermal stimulus could induce heat stress tolerance. { this protecting mechanism needs more research on human cartilage models }.

Wheatley et al. reported that mammalian cells seemed to tolerate temperatures of 42°C, whereas at 43°C cell death rapidly occurred and this became the threshold temperature (10).

Hojo et al have reported that heat stimulus at 41°C for 15 or 30 min increased the viability of chondrocytes, and the borderline temperature that determines the increase or decrease of their metabolism would be between 41°C and 43°C. (11).

Moreover, they have indicated that these effects vary, not only according to temperature but also according to the duration of exposure.

However, the influence of chronic exposure is still unclear (12)

It was demonstrated that the cell viability of the cartilage chondrocytes did not change in the temperature of the range of 32 - 41°C until Day 8 of culture (Fig 5).

The proportion of TUNEL - positive cells on Day 3 was also low at < 1% of the total cells.

Therefore, at temperatures from 32 - 41°C, chondrocytes may not experience cell death, even if exposed for a long period of time.

Many children and young adults are spending prolonged hours with their laptops on their laps daily (12).

Clinical Examination Findings:

'erythema ab igne', "toasted skin syndrome", was reported in a case report (12) on the left thigh of a 17 - year - old girl who used a laptop computer four to five hours daily for nine months who had no past medical history and presented with burning, itching in the erythematous lesions with a brown, reticular, non - blanchable cutis marmorata on the left anterior thigh, approximately the size of a palm. Blood tests were normal for ANA screening. Minimal Dermal Inflammation

was reported on skin biopsy. 'erythema ab igne cause laptop' ("redness from fire") was the diagnosis as she rested her laptop on her thighs for prolonged hours, and the left - sided lesion corresponded to the left - sided battery inside the laptop.



Figure 6: Erythema ab igne (12), which are erythematous lesions with a brown, reticular, non - blanchable cutis marmorata.



Figure 7: The temperature on the thighs was measured after our patient had been sitting with the laptop on her thighs for an hour

The temperature started at 27°C on both thighs, and after an hour was recorded in the article (12) to reach 33 to 38 degrees Celsius.

Redness from fire or Erythema ab igne is also seen usually in the elderly using heating pads or hot - water bottles, stoves, and workers shovelling hot coal.

Continuous exposure causes transient erythema leading to reticulate pigmentation, keratosis which can develop later into squamous cell carcinomas. (13) As this erythema ab igne is precancerous, (14) contact with laptop since childhood must be supervised and regulated and the fact remains that if the heat exposure is stopped early, the prognosis is extremely good.



Figure 8: Shows Second degree burns with erythema, blebs and secondary infection (28)

An incomplete paraplegic with impaired sensations who used a laptop for 5 hours suffered second - degree burns (28) in the area of close contact with the extractor fan of the laptop.

Rarely third - degree thigh burns are also seen.

Most cases can be managed conservatively, while interventions like debridement, grafting, or amputation may have to be done in severe burns.

These severe burns are more likely in Individuals with impaired lower extremity sensation, altered consciousness, or decreased mobility.

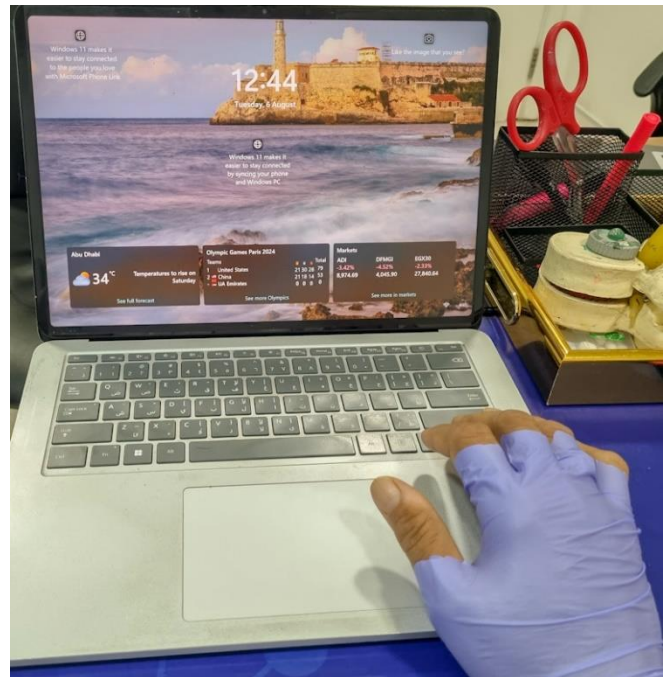
Hence, awareness must be spread among laptop users about the risks of thermal injuries and the importance of using protective equipment to eliminate these hazards.

The scrotal temperature after the thermal exposure may rise to three degrees in one hour, affecting spermatogenesis and ultimately leading to male infertility (15)

Research has revealed that elevated scrotal temperatures may reach 60 degrees, which results in testicular hyperthermia, a condition associated with impaired spermatogenesis in some cases with close contact laptop usage as per a 2004 study published in 'Human Reproduction'. where already previous research has notified that even a rise of 1 to 2 degrees temperature is detrimental for sperm viability (24, 25, 26, 27).

In an article (16), The relationship between laptop usage and the appearance of Angio Lipomatosis, which is presented as mottled skin after being exposed to infrared radiation, was mentioned.

In an article (17), Alsharif S. (2016), R R Riah et al. (18) emphasised the Laptop Computer Induced Erythema ab igne.



Padded gloves for protection against laptop radiations to the wrist

3. Conclusion

New laptops need to be designed with lower radiation emissions.

Gadgets like the olden Microwave radiometry (MR) have to be innovated with alerting sensors with AI tools to alert the user to keep padding or a laptop table as the intensity of the radiation and the tissue temperature have a directly proportional relationship, and these tools must be able to detect the relatively subtle changes of temperature in human tissues in depth non - invasively and accurately as the exposure time to the EMF and infra - red radiations increase with each hour of usage.

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Conflicts of Interest: There is no conflict of interest.

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