Scientific fraud in laser therapy

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A number of reports on scientific fraud have recently been highlighted in the international press. The main stories have been focusing on the affairs in Korea and Norway. Less international attention has been given to a case of scientific fraud in Sweden. The former professor at Karolinska Institutet in Stockholm has been accused of scientific fraud, plagiarism and malpractice and has had to leave the institute.

In a letter, following an inquiry to the Institute, the Dean of research of the Karolinska Institute, Jan Carlstedt-Duke, writes as follows:

"Following a number of allegations made 2002 – 2004, I carried out an investigation of Dr Thomas Lundeberg and his group. The result of this investigation was a clear indication of scientific fraud and malpractice. We therefore asked the Swedish Research Council's expert group on scientific malpractice to make an independent investigation which, due to the complexity of the case, was completed on May 31st this year. The conclusion of this investigation was that scientific malpractice was demonstrated with numerous examples of plagiarism within scientific publications and patent applications. Furthermore, the documentation of the research carried out and its description was so poor, and in many cases lacking, that it was impossible to determine if and when experiments were carried out or by whom. The conclusion of the Rector is that we completely lack confidence in Thomas Lundeberg as a scientist.

Thomas Lundeberg resigned from his position as professor at Karolinska Institutet in October 2003. He has not been associated with Karolinska Institutet since that time and has no affiliation with the university today. He resigned his position following confrontation concerning a manuscript that was used for a patent application and that was plagiarised from a published paper from another group and that contained manipulated data that could not be verified with documented primary data. All connections with Karolinska Institutet were severed following that incident."

It could be added that Thomas Lundeberg has been the instructor of a recent Swedish dental PhD student. The material referred to in the PhD thesis has not been documented and it has been put in doubt that the experiments have ever been performed.

The authors of this article have been sceptical about the research of Thomas Lundeberg (TL) for many years and have also criticized some of his studies in our books. We have tried to create a dialogue with TL but all invitations have been rejected. Since the studies of TL *et al* have had an important influence on the attitudes towards and use of laser therapy in Sweden for more than 15 years, we find it essential to critically scrutinize his laser therapy research.

Ref. 1: Lundeberg T, Hode L, Zhou J. A comparative study of the pain-relieving effect of laser treatment and acupuncture. Acta Physiol Scand. **1987**; 131 (1): 161-162.

In the study acupuncture points were illuminated on rat tails. Laser parameters: HeNe-laser, 632.8 nm, 1.56 mW and GaAs-laser, 904 nm, 73 Hz, 0.07 mW. Conclusion: "*Our results indicate that the analgesic effects reported in humans with similar modes of low power laser might be due to placebo.*" Financial support by The Swedish Society of Medicine.

Our comments: Two things are very serious in this case. 1. The study was published without the knowledge of Lars Hode and he would not have accepted the writing in the present form. 2. The conclusion is most non-scientific. It says that: As we did not get an effect on laser illumination on acupuncture points on a rat tail, the analgesic effects reported in humans with similar modes of low power laser might be due to placebo!!!

Ref. 2: Lundeberg T, Haker E, Thomas M. Effect of laser versus placebo in tennis elbow. Scand J of Rehab Med. 1987; 19: 135-138.

Tennis elbow. Treatment of acupuncture points. No local treatment on painful areas. Used laser parameters: HeNe-laser, 632.8 nm, 1.56 mW, dose per point < 0.1 J and GaAs-laser, 904 nm, 73 Hz, 0.07 mW, dose per point < 0.005 J. Conclusion: **No beneficial effect from laser radiation on tennis elbow**. Financial support from Royal Swedish Academy of Science.

Our comments: Scientifically this study seems to be OK. The result is not surprising with regards to the minimal doses used.

Ref. 3: Lundeberg T, Hode L, Zhou J. Effect of low power laser irradiation on nociceptive cells in Hirudo medicinalis. Acupunct Electrother Res. 1988; 13 (2-3): 99-104.

In this study, "a minimal dissection of the skin and underlying tissue of Hirudo medicinalis (a leech - see fig) was made so that the preparation consisted of a number of body-wall segments connected to their ganglia by three nerve roots". It was mounted on a plastic plate, kept in salt solution, penetrated by electrodes, illuminated with intense white light in a microscope and then illuminated with laser light from HeNe-laser, 632.8 nm, 1.56 mW, and GaAs-laser, 904 nm, 73 Hz, 0.07 mW, in 1, 5 or 10 minutes. Conclusion: "*The non-existing effect of low power HeNe and GaAs on the nociceptors in the present study indicate that the pain alleviating effects reported in other studies with laser stimulation with similar modes of low power laser are likely not explained by effects on nociceptors.*" Financial support from The Swedish Society of Medicine.

Our comments: In this study, Lars Hode did not take part but is listed as a co-author. He was asked before it started if he wanted to take part and he said yes. About half a year later he found out that it was published! The conclusion is completely non-scientific and quite horrendous. The authors (except Lars Hode) concludes that this traumatized tissue from a leech, mounted on a plastic plate, kept in salt solution, penetrated by electrodes, illuminated with intense white light in a microscope and, when illuminated with laser light, did not show any change in their electrical set-up and hence pain alleviating effects reported in other studies with laser stimulation with similar modes of low power laser are likely not explained by effects on nociceptors!

Ref. 4: Lundeberg T, Zhou J. Low power laser irradiation does not affect the generation of signals in a sensory receptor. Am J Chin Med. 1988; 16 (3-4):87-91.

In this study the receptor neuron with its muscle was dissected out from a crayfish (*Astracus fluviatilis*). The neuron was mounted on a glass plate in a salt solution. The neuron was penetrated with a microelectrode. Nerve signals were recorded with and without laser

illumination. Used laser parameters: HeNe-laser, 632.8 nm, 1.56 mW and GaAs-laser, 904 nm, 73 Hz, 0.07 mW. Illumination was performed during 1, 5, 10 and 20 minutes. Conclusion: *Our results indicate that the analgesic effects reported in humans with "laser acupuncture" with similar modes of low power laser are likely not explained by effects on nerve tissue and might be due to placebo.*
Financial support from Royal Swedish Academy of Science and The Swedish Society of Medicine.

Our comments: Lars Hode took part in a more or less identical experiment together with TL where the same dissection was performed. It was done in a microscope with very strong white light illumination. Ambient light like this quickly saturates all possible excitation levels and this could well be one of the reasons for the negative result. The general trauma in the dissection, mounting, electrode insertion and adding salt solution to the neuron could be another reason for lack of effect in this particular set-up. And then concluding: "as they did not see an effect on this crayfish in this study, all other laser studies showing analgesic effects on humans might be due to placebo!" That is completely non-scientific.

Ref. 5: Haker E, Lundeberg T. Laser treatment applied to acupuncture points in lateral humeral epicondylalgia. A double-blind study. Pain. 1990; 43: 243-247.

In this study tennis elbow was treated by laser irradiation of acupuncture points. No local treatment was performed. The laser parameters were: GaAs-laser, 904 nm, 12 mW, 70 Hz and 0.36 joules per point. Conclusion: *Our results do not support the use of laser treatment with the chosen parameters.* Financial support from Foundations of Karolinska Institutet.

Our comments: We cannot judge the chosen acupuncture points in this study as we are not knowledgeable in acupuncture. The usual way to treat tennis elbow is to treat the painful areas locally and in addition places where nerve entrapment can occur. The conclusion is this time quite correct.

Ref. 6: Haker E, Lundeberg T. Is Low-Energy Laser Treatment Effective in Lateral Epicondylalgia? J Pain Symptom Managment. 1991; 6 (4): 241-246.

In this double-blind study, GaAs-laser, 904 nm, 12 mW, 70 Hz. The treatment was locally applied to 6 sites on and around the epicondyle. Each point was treated for 30 seconds, resulting in a dose of 0.36 joules per point. Conclusion: *The statistical analysis showed that the laser treated group had a significant improvement in some objective outcomes after the treatment period and after a 3 month follow-up but there were no significant differences in the subjective outcomes between the groups. Irradia laser treatment may be a valuable therapy in lateral epicondylalgia, if carried out as described in this study. However further studies are necessary before low energy laser should be employed as a pain-relieving method.*
Financial support fromKarolinska Institutets foundations, Stiftelsen Clas Groschinskys Minnesfond, Torsten och Ragnar Söderbergs Stiftelser and the Swedish Association of Registered Physiotherapists.

Our Comments: In this study the same laser parameters as in the previous study were used. We previously criticized the treatment method in the above study, resulting in this second study, being the first and only laser therapy study performed by Thomas Lundeberg with a positive outcome.

Ref. 7: Lundeberg T, Malm M. Low power HeNe laser treatment of venous leg ulcers. Ann Plast Surg. 1991; 27 (6): 537-539.

In this study, a 6 mW HeNe laser or a placebo HeNe laser was used to treat leg ulcers twice weekly for 12 weeks. The stated dose was 4 J/cm^2. The area of the ulcers varied from 3 cm^2 to 32 cm^2. Conclusion: *There were no significant difference in the proportion of healed ulcers or ulcer area in the HeNe group compared with the placebo group.* Financial support from Tore Nilssons Foundation.

Our comments: To achieve the stated dose, the treatment time of each session of therapy would thus have had to vary from 33 minutes to 6 hours. We question that the patients really would have been treated for 6 hours. The method by which the dose was calculated is therefore questionable. No indication is given of the method of treatment. If a scanning laser with an unexpanded beam was used, the power density would have been about 0.15 W/cm^2. If the beam was expanded to a diameter capable of illuminating the whole area of the ulcer at once, the power density when treating the largest ulcer would have been about 0.00019 W/cm^2, which is close to the level of moonlight. Unless more parameters are accounted for, it is impossible to evaluate this study. We tried to get more information from the authors but they refused to answer. We were also interested in how to make a "placebo HeNe-laser". Only a blind person cannot see the difference between red coherent and not coherent light even of the same wavelength, so we question the double-blindness of this study.

Ref. 8. Malm M, Lundeberg T. Effect of low power gallium arsenide laser on healing of venous ulcers. Scand J Plast Reconstr Hand Surg. 1991; 25 (3): 249-251.

The parameters stated in the report are: "A GaAs laser (Irradia) was used. The wavelength was 904 nm, average output 4 mW, peak power 10 W, pulse frequency 3800 Hz and duration 180 ns, and divergence 70 mrad. Energy density was 1.96 J/cm^2. The placebo laser was of the same brand but the invisible GaAs laser light had been removed so that nobody in the study could tell the difference between the two."
Financial support from Karolinska Institutets Foundation, King Gustav Vth 80-year Anniversary Fund, Torsten och Ragnar Söderbergs Foundations and Lars Hiertas Memory Fund.

Our comments: First of all, the treatment time was said to be 10 minutes per patient regardless of wound size. Wound size in the laser group was in the range 4-52 cm^2 (average 12 cm^2). With an average output power of 4 mW and a treatment time of 600 seconds (10 minutes), an energy of 2.4 joules were emitted from the laser in each session. If the whole wound area was treated, the dose (energy density) for the smallest wounds (4 cm^2) must have been 0.6 J/cm^2 and for the largest wounds (52 cm^2) the dose was 0.046 J/cm^2. As the stated dose was 1,96 J/cm^2 something seem to be wrong. We contacted the authors about this, but they refused to give any information. Further, according the manufacturer of the laser equipment (Irradia AB, Sweden), a GaAs laser with as low power as 4 mW has never been produced and a pulse frequency of 3800 Hz is not available with any of their equipment. Neither has a GaAs laser with a beam divergence of 70 mrad (collimated) been available.

Ref. 9. Haker EH, Lundeberg TC. Lateral epicondylalgia: report of noneffective midlaser treatment. Arch Phys Med Rehabil. 1991; 72 (12):984-988.

In this study, the laser used was a Space Mid Laser Mix 5-up with 5 GaAs laser emitters and one HeNe emitter in the centre. The parameters for the GaAs lasers are: wavelength 904 nm, pulse duration 180 ms, pulse frequency 3800 Hz, peak power 10 W and average output power 4 mW. The HeNe parameters are: wavelength 632.8 nm, continuous, power output 5 mW and beam divergence 70 mrad. A GaAs pen laser was also included (output power not specified).

The probe was used to "radiate over the area over the epicondyle" for eight minutes; then the pen laser was used to radiate two points corresponding to the acupuncture points LI 11 and LI 12 for two minutes per point. The probes were "applied perpendicularly over the painful area". Conclusion: The result of this study does not support the use of Space Mid Laser Mix 5-up (GaAs + HeNe) in the treatment of lateral epicondylalgia. Financial support from Karolinska Institutets Foundation, the Swedish Association of Registered Physiotherapists, Stiftelsen Clas Groschinskys Minnesfond and Torsten och Ragnar Söderbergs Stiftelser.

Our comments: In this laser the 5 GaAs-laser diodes are placed in symmetry, approximately 2 cm apart in a regular pentagon with a HeNe-laser in the centre. The probe was held in contact, which means that 6 points were illuminated with light beams, spaced about 2 cm apart. How this is related to the epicondyle or other painful sites is not described, but if the epicondyle is in the centre, it is only illuminated by the HeNe laser and the GaAs lasers are irradiating points about 2 cm away. Further it is said that in the placebo group the invisible GaAs-laser light was switched off and the HeNe-laser was replaced by a red light emitter and hence "no difference in the machines appearance was observed by the assistant who carried out the treatments or any other person who was involved in study". This is of course wrong as everyone immediately would see the difference in light appearance. Due to the details mentioned above, it is difficult to judge this study.

With the shortcomings mentioned above we find it reasonable to doubt the veracity of much of the material in the above studies and care should be taken when using these studies as references. The inclusion on Medline of some of these studies may also be questioned.