

Lasers in Medicine

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How we got here....

- From the realisation of the laser in 1960, medicine has found many uses – some ill conceived and short-lived, others profoundly influencing diagnosis and treatment
- What is it about a laser which makes it so important?
 - Pure “colour” (monochromatic)
 - Collimated or parallel beam
 - High intensity

Laser interactions

- Heat
 - Most laser effects in tissue involve heat, ranging from -60° to well over 1000° C
- Interaction with tissue components
 - In the visible and near-visible light region, natural tissue components (haemoglobin, melanin and water) and exogenous materials such as tattoo pigment, absorb certain wavelengths more than others

Thermal effects

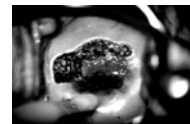
- $<100^{\circ}$ C
 - Protein denaturation, coagulation
- $\sim 100^{\circ}$ C
 - Water evaporation (tissue shrinking)
- $\sim 300^{\circ}$ C
 - Tissue ablation
 - Smoke plume
- $>\sim 600^{\circ}$ C
 - Carbonisation

Tissue Interactions

- We can “target” certain tissues such as the retina or prostate (haemoglobin), use the varying absorption of water in the infrared region (cutting, epidermal or dental treatments), create shock waves (lithotripsy), create microbubbles (LASIK corneal flap preparation), or use totally harmless intensities to react with natural or introduced agents (photodynamic therapy, low level laser therapy)

Thermal Application Examples

- Cervical intra-epithelia neoplasia (CIN)
 - CO_2 laser
- Facial resurfacing
 - CO_2 or Er:YAG laser



- Prostate removal
 - Green lasers – prostate ablation
 - Ho:YAG (Ho - LEP or HoLAP)

- Excision of laryngeal tumours
 - CO₂ laser



Vascular

- Endovenous laser therapy
 - Varicose veins (saphenous)
 - Partial replacement for vein stripping
 - Thermal coagulation of vein wall with surrounding tumescent anaesthesia
 - Vein and content collapse and are absorbed

Shock Wave Effects

- Tattoo removal
 - Pulsed Nd:YAG laser + others



- Renal lithotripsy
 - Pulsed Ho:YAG laser



Low level laser therapy

- No thermal or other frank effects – entirely cellular or light-mediated chemical effects
 - Wound healing
 - Acupuncture
 - PDT
 - Pain relief

Chemical or Cellular Effects

- Pain relief, acupuncture, wound healing, photorejuvenation
 - Various visible and near-visible, low power lasers
- Photodynamic therapy – cancer, AMD, scars, fungi
 - Various lasers, targeting absorption in an introduced chromophore

Ophthalmology

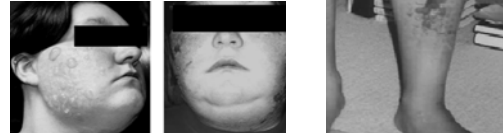
- Probably greatest laser success story
 - Posterior capsulotomy (post IOL implant) – Nd:YAG
 - Iridotomy, trabeculectomy – Nd:YAG +
 - LASIK/PRK – excimer, near infrared (corneal flap)
 - Retinal welding – green
 - Retinal photocoagulation - green

Cosmetic

- Largely, but not entirely thermal
- Facial resurfacing
- Superficial vascular lesions (port wine stains, rosacea, etc)
- Hair removal
- Wrinkle treatment
- Blephoroplasty
- Acne scarring (PDT)

..the downside

- In the wrong hands, things CAN go wrong
 - Mainly lack of understanding of tissue effects
 - OR poor equipment
- Proper training and accreditation



Non-laser devices

- IPL – intense pulse light sources
 - Can be a replacement for lasers
 - Not internationally standardised
 - More adverse effects than from lasers (but this is mostly a training issue)
 - Bypass regulatory controls (but this is changing)

The message

- Lasers have a definite and long-term place in therapeutic medicine
-and I haven't even considered diagnostic medicine
- Must be used with care, by trained and qualified persons
- Patient and staff risks are real, but very low incidence.....however....!

