Lasers in dermatology
beyond cosmetic uses

Technological advances and consumer demand have led to the increasing use of lasers in dermatology for a range of medical and cosmetic skin treatments. However, new lasers are arriving at a bewildering rate, often before their effectiveness has been properly evaluated by clinical studies. Which laser treatment is suitable for which skin condition?

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Recent advances in laser technology have received a great deal of media attention. This has been driven largely by public interest in, and the demand for, cosmetic medicine. Lasers are being promoted for a great number of cosmetic uses, such as eradicating wrinkles, 'permanently' removing hair and even eliminating stretch marks. The accuracy of such advertising, the controversy about who is best qualified to perform laser surgery, and the influence of financial incentives have greatly concerned many in the medical community, as well as patients.

While the ethics surrounding cosmetic medicine arouse much debate, there is no question that the commercial weight of this burgeoning medical industry has stimulated many recent developments in laser technology. At the same time, these new advances have enriched the therapeutic armamentarium available to dermatologists for managing 'traditional' cutaneous problems. This paper aims to provide an overview of the more significant developments in this exciting area and to outline conditions that may be suitable for laser treatment.

Laser development

Goldman has been attributed as the first person to realise the potential clinical application of lasers in dermatology. His first publication in 1965 reported the use of a ruby laser to remove tattoos. In 1968, he used an argon laser to treat port wine stains.

However, early lasers were relatively nonspecific and were associated with significant rates of scarring. Technological improvements followed and during the early 1980s, Anderson and Parish developed the concept of selective photothermolysis, which unveiled lasers' true potential. This type of photothermolysis is the precise, thermally mediated injury of specific cutaneous targets by selectively absorbed pulses of radiation, and has three main features.

- A laser light is used with a wavelength that is preferentially absorbed by the desired tissue

IN SUMMARY

- **The scope of skin conditions that are suitable for laser therapy is growing nearly as fast as the number of new lasers on the market. However, not all these therapies have been evaluated by proper clinical trials, complicating patients' treatment options.**
- **Laser therapy works by selective thermolysis – the precise, thermally mediated injury of specific cutaneous targets by selectively absorbed pulses of radiation.**
- **It can be used to treat cutaneous vascular lesions or pigmented lesions, or for cutaneous resurfacing.**
- **Side effects may include scarring, pigmentary changes and infection; anaesthesia may be required; and not all treatments are listed on the Medical Benefits Schedule.**

target. For example, yellow light lasers are used to treat vascular lesions because haemoglobin preferentially absorbs wavelengths that correspond to yellow light.
- The length of the laser pulse is limited to less than, or equal to, the time necessary to cool a target structure. This time is determined by the structure's thermal relaxation time (i.e. time taken for a structure to cool by half the temperature to which it has been heated). The procedure, therefore, minimises heat conduction (thermal injury) to surrounding tissues.
- A laser pulse with sufficient energy is used to produce a damaging temperature in the target.

Dermatologists use lasers for three broad types of treatment, which are described in turn below.

Cutaneous vascular lesions

Several lasers are available for the treatment of vascular lesions. Two of the most popular are the flashlamp-pumped pulsed dye laser (e.g. Candela laser) and potassium titanyl phosphate lasers.

Port wine stains

Selective photothermolysis evolved, at least in part, through attempts to develop a safe and effective laser to treat port wine stains (capillary malformations) in children. The result was the flashlamp-pumped pulsed dye laser, a laser that is energised by a flashlamp and emits a yellow light. This laser, also known as a Candela laser, revolutionised management of port wine stains and awoke many in the medical community to the immense potential of lasers as therapeutic tools for a much wider range of clinical applications.

Candela lasers are an efficacious and safe means of treating children with capillary malformations (Figures 1a and 1b) and are available at several paediatric and adult hospitals in Australia. Laser treatment should start at the earliest sign of a lesion, with at least three treatments required. Infants only a few weeks old can be safely treated. Complications with Candela laser treatment are very uncommon. In the largest reported study of 500 patients, atrophic scarring occurred in fewer than 0.1%, hyperpigmentation in 1% and transient hypopigmentation in 2.6%.

Port wine stains

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Figures 1a and b. a (left). Before treatment. b (right). After Candela laser treatment.

Haemangiomas

Haemangiomas are the most common tumours of infancy and are characterised by endothelial cell hyperplasia. In contrast, port wine stains are classified as capillary malformations and have normal endothelial cell turnover. Most haemangiomas resolve spontaneously. Therapeutic intervention is recommended only for lesions that are complicated by:
- ulceration
- pain
- skeletal distortion and potentially permanent disfigurement (e.g. nasal tip lesions)
- the potential to produce functional problems such as respiratory obstruction or periorbital haemangiomas obstructing vision (causing amblyopia)
- recurrent bleeding.

When treatment is indicated, systemic corti-

Facial telangiectasia

Figures 2a and b. a (left). Before treatment. b (right). After two treatments with Candela laser.

Actinic cheilitis

Figures 3a and b. a (left). A 52-year-old man before treatment. b (right). Three months after treatment with an erbium laser.

Diffuse facial actinic damage

Figures 4a and 4b. a (left). Diffuse facial actinic damage in a 43-year-old woman 10 years post cardiac transplant. Note the multiple solar keratoses and marked pigmentary dyschromia before treatment. The hypopigmented area on the upper lip is a result of radiotherapy for previous squamous cell carcinoma. b. (right). Four weeks after facial resurfacing with an erbium laser.

costeroids are generally the first line of therapy. Interferon-α, surgical excision, embolisation and laser therapy are sometimes invaluable adjuncts, alone or in combination. Ulcerated haemangiomas are one of the best indications for laser treatment, and are effectively treated with a Candela laser. Superficial haemangiomas can also be treated with a Candela laser.

Facial telangiectasia

Severe facial telangiectasia may have significant negative effects on self-image and is a good indication for laser therapy (Figures 2a and 2b). Telangiectasia is most common in patients with sun damage and fair complexions. It is often familial and may be associated with rosacea. There are various laser systems that can effectively treat facial telangiectasia. Significant clearing (greater than 75%) is usually achieved with one treatment. Purpura is a universal sequela of Candela laser therapy and resolves within 10 days. Common side effects of other vascular lasers include erythema, swelling, and crusting which resolve over a few days.

Other lesions

Less well established indications for Candela laser therapy include verrucae and hypertrophic or keloid scars. Res-ponse rates for verrucae range from 21% to more than 90%. Intralesional steroids are often used as an adjunct in the management of scars but not verrucae. Early, vascular scars are probably more responsive to laser treatment. However, a recent prospective, controlled study found no difference in improvement with a Candela laser compared with controls.[3]

Cutaneous resurfacing

Carbon dioxide and erbium lasers used in cutaneous resurfacing emit wavelengths of light that are efficiently absorbed by water. These lasers destroy tissue by instantaneously heating intra-

cellular water, which results in vapourisation and cellular ablation. Early CO_2 lasers produced a continuous beam and were used mainly for destroying epidermal tumours. These lasers were an alternative to the curette and electrocautery unit, and are still used to treat bulky lesions such as warts and rhinophyma.

As the subtleties of laser tissue interactions were revealed in the 1980s, pulsed CO_2 and then erbium lasers were developed. These operated according to the principles of selective photothermolysis and their arrival on the cosmetic scene heralded the so-called 'laser era'. These lasers enabled much more precise control of tissue vapourisation and minimised thermal damage to surrounding tissue. This reduced the risk of scarring compared with early CO_2 lasers, and other less selective treatments such as cryotherapy and electrocautery. While resurfacing lasers have certainly not replaced these more traditional therapeutic methods for treating skin problems, they are a useful alternative for some conditions, and in some circumstances are the treatment of choice.

Actinic cheilitis

Actinic cheilitis is an established indication for CO_2 laser treatment. Newer erbium lasers produce results equal to the CO_2 laser and have the advantage of more rapid healing (Figures 3a and 3b). Surgical vermilionectomy for actinic cheilitis has now been relegated to the archives of medical history, although it may provide an alternative treatment when access to laser surgery is limited.

Superficial nonmelanoma skin cancer

Laser ablation of intraepidermal squamous cell carcinomas (Bowen's disease) and superficial basal cell carcinomas may be considered for select lesions as an alternative to traditional methods. Laser treatment is most useful for larger facial lesions where surgical excision may produce an unacceptable cosmetic outcome.

Surgical scar

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Figures 5a and b. a (left). Note the surgical scar on the nose following excision and bi-lobed flap repair for basal cell carcinoma. b (right). After CO_2 laser resurfacing.

Rhinophyma

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Figures 6a and b. a (left). Severe rhinophyma before treatment. b (right). After CO_2 resurfacing.

Resurfacing for diffuse facial actinic damage

Resurfacing lasers have made their greatest impact in the cosmetic arena, specifically for treating rhytides (wrinkles), pigment dyschromia and other changes characteristic of photoageing. However, they are also useful in managing patients with diffuse facial dysplastic change (Figures 4a and 4b). The efficacy of resurfacing lasers for this indication needs to be established by controlled, long term, follow up studies.

Warts

Recalcitrant warts, particularly periungual and plantar warts, are reasonable indications for CO_2 laser ablation, although recurrence rates are similar to those following other treatments.

Other indications

Other indications for CO_2 or erbium laser ablation include:

- scars, for example traumatic, surgical (Figures 5a and 5b), and post acne scarring

Facial angiofibromas

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Figures 7a and b. a (left). Facial angiofibromas (adenoma sebaceum) in a patient with tuberous sclerosis, before treatment. b (right). After CO_2 resurfacing.

Pigmented lesions

Naevus of Ota

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Figures 9a and b. a (left). Before treatment. b (right). After treatment with Q-switched Nd:YAG laser.

- rhinophyma (Figures 6a and 6b)
- epidermal naevi
- benign dermal tumours, for example angiofibromas (tuberous sclerosis, Figures 7a and 7b), trichoepitheliomas, syringomas
- epidermal pigmentation (lentigines, melasma).

Pigmented lesions

Pigmented lesions may be classified as epidermal or dermal depending on the depth of the pigment. The pigment may be derived from exogenous sources (e.g. tattoos), or endogenous compounds (e.g. melanin).

Epidermal pigmented lesions can be removed with resurfacing lasers (Figures 8a and 8b). However, these lasers are not used for pigmented lesions that are purely dermal because of the risk of scarring associated with ablation of the dermis and the contained epidermal appendages (e.g. hair bulbs) that are essential for normal skin healing.

Melanin has a broad absorption spectrum and is the obvious target for specific pigment lesion lasers including the Q-switched ruby laser and Q-switched alexandrite laser. Q-switched is short for quality switch, a mechanism used to produce very short pulses (20 to 40 ns) of high energy laser light. They can effectively remove epidermal and dermal pigmented lesions by rapidly heating the melanin stored in the skin's melanosomes.

Most pigmented lesions are considered a cosmetic problem rather than a medical one; the distinction is not always clear. Laser treatment of some pigmented lesions, however, is listed on the Medical Benefits Schedule. Conditions include severe melasma, café-au-lait macules, and naevus of Ota.

Melasma

Melasma is a symmetrical, light-to-dark brown facial hypermelanosis that may be purely epidermal, purely dermal, or

mixed. It may be idiopathic or associated with pregnancy, or use of the oral contraceptive pill.

Laser treatment may be considered when melasma fails to respond to standard therapy, namely sunblock and bleaching agents (3 to 4% hydroquinone cream), tretinoin or glycolic acid preparations. Topical therapy is essential after laser treatment to prevent recurrence.

Café-au-lait macules

Café-au-lait macules have been treated with pigmented lesion lasers. However, results are variable with most studies reporting a 50% recurrence rate.

Naevus of Ota

Naevus of Ota is most common in women of Asian descent and is characterised by a bluish, grey benign macular lesion appearing on the facial skin in areas innervated by the first and second divisions of the trigeminal nerve (Figures 9a and 9b).

Histology reveals increased melanocytes in the reticular dermis. Several studies have demonstrated excellent responses to Q-switched pigmented lesion lasers.

Anaesthesia

Laser procedures can usually be performed with either no anaesthesia, or topical or local anaesthesia. Intravenous sedation or general anaesthesia is often preferred for infants undergoing laser therapy for vascular birthmarks.

For extensive procedures involving skin resurfacing with CO_2 or erbium lasers, intravenous sedation, general anaesthesia or tumescent anaesthesia is required.

Simple analgesia following resurfacing procedures is usually sufficient.

Cost

The cost for laser procedures is highly variable. Medicare rebates are provided for most of the medical conditions discussed above but patients should be advised to inquire about the total cost before undertaking treatment.

Complications

The risk of complications can be minimised by careful patient selection and using the appropriate laser parameters.

- Scarring, especially with resurfacing lasers.
- Pigmentary changes, for example temporary hyperpigmentation, is common after treating patients with dark skin. Hypopigmentation may also occur in darker skin types, is more likely to persist, and may be permanent. Most dermatologists test a small area of before treating larger areas if they feel there is significant risk of pigmentary alterations.
- Infection, for example reactivation of herpes infection in a treated site, is possible with any of the lasers mentioned above. Bacterial and candida infections are additional concerns with resurfacing procedures where the integrity of the skin is disrupted. The risk of infection is minimised by antiviral or antibiotic prophylaxis and appropriate skincare regimens following laser procedures.

Conclusion

Laser technology has facilitated the treatment of various medical and cosmetic cutaneous problems. They can be used for cutaneuos resurfacing and to treat both pigmented and cutaneous vascular lesions.

The scope of conditions for which lasers are a therapeutic consideration grows at a rate surpassed only by the number of new lasers arriving on the market. Unfortunately, these lasers are often promoted as being effective for conditions before undergoing critical evaluation by proper scientific methods.

This article highlights some of the dermatological conditions for which lasers may be considered an appropriate therapeutic option. MT

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Further reading

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