ISSN:0975-3583,0976-2833 VOL12,ISSUE05,2021

Acne vulgaris Scars Treatment Options: An updated and Comprehensive Review

Khaled Gharib [1], Sahar Abdel Satar[1], Elsayed Khater[1]

[1]Dermatology and venereology department, Faculty of medicine, Zagazig university, Alsharquia, Egypt.

Correspondence: saharabdelsatar22@gmail.com

ABSTRACT

Acne is a complex condition affecting the pilosebaceous unit. It is one of the most often treated dermatological conditions. It affects 85 percent of people aged 12 to 24. It typically begins throughout puberty and is more prevalent in males than females. Even in their fourth decade of life, many adults are troubled by acne, but it affects more women than males. Although numerous therapeutic techniques for acne have been documented, it is difficult to treat acne with minimum side effects. We treated a patient with acne vulgaris in this report utilizing long-pulsed neodymium: yttrium-aluminum-garnet (Nd:YAG) lasers at a wavelength of 1,064 nm. After two sessions of long-pulsed 1,064-nm Nd:YAG laser treatment, the patient achieved virtually complete remission with no significant side effects or recurrence during a six-month period. We propose that a long-pulsed 1,064-nm Nd:YAG laser can be utilized efficiently and safely in Asian patients to treat inflammatory lesions of the skin, notably acne vulgaris.

Keywords: Acne vulgaris, Long-pulsed 1, 064 nm, Neodymium: yttrium-aluminum-garnet laser

1. INTRODUCTION

Acne vulgaris is one of the most common chronic skin diseases of pilosebaceous units with multifactorial pathogenesis. Acne development is commonly associated with excessive follicular keratinization, leading to follicular plugs (comedones), androgen related hyperplasia of the sebaceous glands and increased sebum, colonization with *Propionibacterium acnes* and inflammatory response. Clinically it can be classified as inflammatory and non-inflammatory acne. In non-inflammatory acne, comedones can be observed, while inflammatory acne is associated with papules, pustules and nodulocystic lesions causing atrophic or hypertrophic scars **[1]**. The most affected areas with the greatest number of sebaceous glands are the face, neck and upper torso.

Acne is most prevalent among adolescents and young adults, affecting approximately 80% of people between 11–30 years of age, however it is also present in children and adults **[2-3]**.

Due to the large impact on quality of life, acne is no longer regarded simply as a physiological condition or a cosmetic problem. There is a great need for safe and effective treatments of acne. Large numbers of local and systemic therapies are available for acne treatments. Common oral or topical retinoids, antibiotics or keratolytics are used but are inconvenient, and side effects caused by these conventional therapies prompted a search for more acceptable treatments.

An increase in research regarding effective acne treatments with different light sources, including laser source treatment, has been detected recently [4]. Although, there are numerous studies describing the efficacy of 1064 nm Nd:YAG lasers for the treatment of acne scars **[5-6]**, there is little known about their efficacy against acne infection treatment **[7]**.

In this paper, four cases of successful treatment of acne vulgaris with long-pulsed 1064 nm Nd:YAG laser have been reported.

2. TREATMENT OF ACNE

Different treatments exist for acne. These include alpha hydroxy acid, antibiotics, anti-androgen medications, antiseborrheic medications, benzoyl peroxide, hormonal treatments, azelaic acid, keratolytic soaps, nicotinamide, retinoids, and salicylic acid. Gollnick discussed different modalities for acne vulgaris treatment according to its severity**Table (1) [1].**

2.1. Diet

A diet low in simple sugars is recommended as a method of improving acne. As of 2014, evidence is insufficient to recommend milk restriction for this purpose **[3]**.

2.2.Medications

a) Benzoyl peroxide

Benzoyl peroxide (BPO) is a first-line treatment for mild and moderate acne due to its effectiveness and fewer side-effects. In the skin follicle, benzoyl peroxide kills P. acnes by oxidizing its proteins

ISSN:0975-3583,0976-2833 VOL12,ISSUE05,2021

through the formation of oxygen free radicals and benzoic acid. These free radicals interfere with the bacterium's metabolism and ability to make proteins. Also, benzoyl peroxide is effective at breaking down comedones and inhibiting inflammation. Benzoyl peroxide may be paired with a topical antibiotic or retinoid such as benzoyl peroxide/clindamycin and benzoyl peroxide/adapalene, respectively **[4]**.

b) Retinoids

Retinoids are medications that reduce inflammation, normalize the follicle cell life cycle, and inhibit production of sebum. They are structurally related to vitamin A. Retinoids influence the cell life cycle in the follicle lining. This prevent the accumulation of skin cells within the hair follicle that can create a blockage. They are a first-line acne treatment, especially for people with dark-colored skin, and are known to cause rapid improvement of postinflammatory hyperpigmentation **[5].**

c) Antibiotics

Antibiotics are applied topical to the skin or taken orally to treat acne. They work through their antimicrobial activity against P. acnes and their ability to reduce inflammation. Antibiotics are becoming less effective with the widespread use for acne and an increased antibiotic-resistant P. acnes, especially macrolide antibiotics like topical erythromycin **[5].**

d) Hormonal agents

In women, acne can be improved with the use of any combined contraceptive pill. These decrease the production of androgen hormones by the ovaries, leading to lower skin production of sebum, and reduce acne severity. Combinations containing third- or fourth-generation progestins such as desogestrel, and norgestimate are more effective**[6].**

e) Azelaic acid

Azelaic acid has been shown to be effective for mild to moderate acne when applied topically at a 20% concentration. It is necessary to be applied twice daily for six months. It is as effective as topical benzoyl peroxide 5%, erythromycin 2% and isotretinoin 0.05%. Azelaic acid is thought to be an effective treatment due to its ability to reduce accumulation of skin cell in the follicle, and its antibacterial and anti-inflammatory properties **[7].**

f) Salicylic acid

Salicylic acid is a topically applied beta-hydroxy acid that stops bacteria from reproducing and has keratolytic properties. It opens obstructed skin pores and increase shedding of epithelial skin cells. Salicylic acid is known to be less effective than retinoid therapy **[8].**

g) Other medications

Topical and oral preparations of zinc have been proposed as effective treatments for acne. The purported efficacy of zinc is attributed to its capacity to reduce inflammation and sebum production and inhibit P. acnes. Gastrointestinal side effects associated with oral zinc may limit its use **[9]**.

h) Combination therapy

Frequently used combinations include the following: antibiotic and benzoyl peroxide, antibiotic and topical retinoid, or topical retinoid and benzoyl peroxide. The pairing of benzoyl peroxide with a retinoid is preferred over the combination of a topical antibiotic with a retinoid since both regimens are effective but benzoyl peroxide does not lead to antibiotic resistance **[10]**.

2.3. Procedures for acne treatment

Comedo extraction t is recommended for comedones that do not improve with standard treatment. Another procedure for immediate relief is injection of a corticosteroid into an inflamed acne comedo. Electrocautery and electrofulguration have also been reported as effectivetreatments for comedones**[11]**.

2.4. Devices for Acne Treatment

a) RadiofrequencyDevices

Fractional radiofrequency treatment with insulated microneedles targeting the middermis has shown promise in treating inflammatory acne lesions. Side effects include pinpoint bleeding at the sites of treatment, pain, and redness. Radiofrequency treatments do not cause hyperpigmentation (no epidermal heating), and thus may be a viable option for patients with darker skin types **[12]**.

b) Light therapy

Light therapy involves delivering specific wavelengths of light to an area of skin affected by acne. Both regular and laser light have been used. Light- and laser-based treatment options have become established as an alternative to traditional topical and oral medications **[13]**.

c) Lasers for Acne Treatment:

Pulsed-dye lasers (PDL) cause selective photothermolysis of dilated blood vessels within acne lesions. While there is no direct effect on P. acnes or sebum production, the soluble factor transforming growth factor (TGF)-β (a cytokine involved in wound healing) is up-regulated after non-ablative PDL therapy. TGF-β mediate an anti-inflammatory effect that manifests as a global

ISSN:0975-3583,0976-2833 VOL12,ISSUE05,2021

improvement in acne appearance rather than limited to the treated site. The lack of high-quality controlled trials has made it difficult to interpret conflicting reports of PDL efficacy **[14]**.

The 1,450 nm diode laser was shown to damage sebaceous glands. Photothermolysis at the level of the sebaceous gland and alteration in follicular hyperkeratinization may play a role. A split-back randomized controlled trial showed significant decrease in acne lesion counts compared with control sites. In follow-up studies, most of the patients were concomitantly receiving either an oral or topical acne regimen during the laser treatment **[15]**.

3. TREATMENT OF ACNE SCARS

Treatment of acne scarring remain a challenge for both patients and dermatologists. Each type of scar has a different structure which needing a personalized approach. The selection of an approach to treatment is based upon factors such as the type and degree of acne scarring, patient preference, side effects, cost, and treatment availability. A multimodality approach for scar treatment is usually necessary to achieve the best cosmetic results **[16]**.

3.1. Chemical peeling:

By chemical peeling we mean applying chemicals to the skin to destroy the outer damaged layers and accelerate the repair process **[17]**.

a)***Glycolic Acid:***

Glycolic acid is an alpha-hydroxy acid, soluble in alcohol, derived from fruit and milk sugars. Glycolic acid acts by thinning the stratum corneum, promoting epidermolysis and dispersing basal layer melanin. It increases dermal hyaluronic acid and collagen gene expression by increasing secretion of IL-6 **[18]**.

b): ***Trichloroacetic Acid:***

The use of trichloroacetic acid (TCA) as a peeling agent was first described by P.G. Unna, a German dermatologist, in 1882. Application of TCA to the skin causes denaturation of protein, the so-called keratocoagulation, resulting in a readily observed white frost. For the purposes of chemical peeling, it is mixed with 100 mL of distilled water to create the desired concentration **[19]**.

c: Salicylic Acid:

Salicylic acid is one of the best peeling agents for the treatment of acne scars. It is a beta hydroxy acid agent which eliminate intercellular lipids that are linked to the cornified envelope surrounding cornified epithelioid cells. The most effective concentration for acne scars is 30% in multiple sessions, 3–5 times, every 3-4 weeks **[20]**.

They are believed to work in at least four different ways, including the following: reducing inflammation, killing P. acnes, hormonal manipulation, and normalizing skin cell shedding and sebum production in the pore to prevent blockage. Commonly used treatments include topical therapies such as antibiotics, benzoyl peroxide, retinoids, and systemic agents including antibiotics, hormonal agents, and oral retinoids **[21]**.

Table (1): Showing acne treatment algorithm [1].

	Mild		Moderate		Severe
	Comedonal	Papular/ Pustular	Papular/ pustular	Nodular	Nodular/ Conglobate
First choice:	Topical Retinoid	Topical retinoid + topical antimicrobial	Oral antibiotic + topical retinoid +/- BPO	Oral antibiotic + topical retinoid +/- BPO	Oral isotretinion
Alternatives:	Azelaic acid or salicylic acid	Alternative topical antimicrobial agent + alt. topical retinoid or azelaic acid	Alt. oral antibiotic +alt. topical retinoid +/- BPO	Oral isotretinion or alt.oral antibiotic + alt.topical retinoid +/- BPA/Azelaic acid.	High dose oral antibiotic + topical retiniod + BPO
Alternatives for females:	See first choice	See first choice	Oral anti-androgen + topical retinoid/Azelaic acid +/- BPO	Oral antiandrogen + topical retioid +/- oral antibiotic +/- alt. antimicrobial	High dose oral anti-androgen + topical retinoid +/- alt. antimicrobial

ISSN:0975-3583,0976-2833 VOL12,ISSUE05,2021

Maintenance therapy:	Topical retinoid	Topical retinoid +/- BPO

4. LASERS FOR POST ACNE SCARS

4.1 Basics of laser

A laser is a device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation. The term "laser" originated as an acronym for "light amplification by stimulated emission of radiation", The first laser was built in 1960 **[22]**.

Laser is an effective treatment for post acne scars, and it is more promising to use than other modalities. Different types of laser, including non-ablative and ablative lasers, are very useful. The mechanism concerns stimulating the fibroblasts to replace lost dermal components of the collagen and elastin, in order to fill and full scar defect **[23]**.

4.2. Ablative lasers

Ablative lasers can stimulate profound dermal remodeling, but require significant downtime and the associated side effects include persistent erythema, edema, oozing, and crusting **[24]**.

4.3. Nonablative lasers

Nonablative laser systems are also used to treat atrophic acne scars. They emit wavelengths in the visible or in the infrared (IR) range, resulting in stimulation of type I and III collagen and elastic fibers **[25]**.

4.4. Pulsed Dye Laser

The use of pulsed dye laser (PDL) has provided good results in the treatment of hypertrophic/ keloidal scars over the last 10years.Several studies have been conducted to investigate how the PDL works on hypertrophic/ keloidal scars. They have revealed that PDL minimize the number and proliferation of fibroblasts and collagen fibers appear looser and less coarse **[26]**.

4.5. 1064 nm Nd:YAG laser:

Nd:YAG Lasers generally produce an infra-red laser (1064 nm), It works primarily by heating the water molecules in the treatment area.When used at low power, infra-red lasers are used to stimulate cells by heating them up, but not enough to kill them. When used at high power, infra-red lasers can destroy (ablate) the target tissue very quickly.Ablative laser therapy with Nd:YAG Lasers is a popular technique to resurface the skin and treat scars by removing scar tissue, Infra-red lasers like Nd:YAG can be quite effective in penetrating deeper into skin and tissue at repairing deep scars **[27]**.

a) Role of 1064 nm Nd:YAG laser in post acne scar:

Among the nonablative lasers most commonly used are the 1320- and 1064-nm neodymium-doped yttrium aluminum garnet (Nd:YAG) and the 1.450-nm diode lasers. The 1.320-nm Nd:YAG laser cools the surface of the epidermis while penetrating into the deeper layers of the skin with infrared wavelengths. These wavelengths target the underlying water and collagen without disrupting the epidermis **[28]**.

In Q-switched mode, Nd:YAG produces 2 wavelengths, one in the infrared range (1064 nm) and a second beam of 532 nm wavelength which is useful for superficial skin lesions. Q-switching refers to thetechnique of making the laser produce a high intensity beam in very short pulses **[29]**.

Neodynium YAG laser works by emitting a wavelength of high energy light, which when focused on a certain skin condition will create heat and destroy diseased cells **[30]**.

Nd:YAG lasers target water in the dermis to stimulate collagen synthesis showed modest efficacy after 3 to 6 treatments in improvement of atrophic and acne scarring **[31]**.

The 1064-nm Nd:YAG laser penetrates more deeply into the dermis and exhibits a greater extent of absorption by oxyhemoglobin and melanin. There are several varieties of 1064-nm Nd:YAG lasers, including the long-pulsed, short-pulsed, and Q-switch lasers. In general, clinical outcomes for atrophic scars range between 20% and 30% mean improvement; but recovery and adverse effects are favorable compared with ablative systems **[32]**.

The Q-switched Nd:YAG (1064 nm) laser is characterized by very short pulse width, which produces dermal changes mainly by the photomechanical effect of laser beam; moreover, the Q-switched laser has less water absorption and lower scattering, which results in a relatively deeper dermal penetration**[33].**

ISSN:0975-3583,0976-2833 VOL12,ISSUE05,2021

Also because1064 nm neodymium-yttrium-aluminum-garnet (Nd:YAG) laser reaches more deeply than many of other lasers, it is increasingly being used to treat deep vascular diseases such as hypertrophic scars **[27]**and keloids It has been suggested that it acts by suppressing neovascularization in these pathological scars, which are characterized by vessel overgrowth that results in nerve fibers and collagen in the reticular layer of the dermis **[34].**

The low side effects of these non-ablative systems including local erythema, edema, vesiculation or herpes simplex reactivation and in some rare cases a post inflammatory hyperpigmentation, compensate for their reduced clinical efficacy **[35]**.

Several factors contribute to the fact that uniform laser parameters in clinical practice do not exist. While several clinical and histologic studies have been reported in the medical literature, varying styles of laser practice between dermatologists affect end clinical results. In addition to the laser parameters chosen, for example, clinical effect is also influenced by the number of laser passes delivered, the degree of pulse or scan overlap, the complete/incomplete removal of partially desiccated tissue between each laser pass, preoperative preparation, and postoperative wound care**[36]**.

b) ***Side effects of neodynium YAG laser treatment [37]:***

Side effects from Nd:YAG laser treatment are usually minor and may include:

Pain during treatment (reduced by contact cooling and if necessary, topical anaesthetic).Redness, swelling and itching immediately after the procedure that may last a few days after treatment.Rarely, skin pigment may absorb too much light energy and blistering can occur (this settles by itself).Changes in skin pigmentation. Sometimes the pigment cells (melanocytes) can be damaged, leaving darker (hyperpigmentation) or paler (hypopigmentation) patches of skin. Generally, cosmetic lasers will work better on people with lighter rather than darker skin tones.Bruising affects up to 10% of patients. It usually fades on its own.Bacterial infection, Active infections of any kind (fungal, bacterial, or viral) are relative contraindications to the laser, and should be treated properly before the laser session.

Inflammatory skin disorders on the area to be treated, like eczema or psoriasis, are not to be submitted to the procedure until their complete resolution. Patients with inflammatory skin diseases that have Köebner phenomenon (lichen planus, psoriasis, perforating dermatosis, vitiligo, etc), even outside the area to be treated, shall be well informed of this possibility.

References:

1. **Gollnick H., Cunliffe W., Berson D. et al., (2003):** "Management of acne": a report from a Global Alliance to Improve Outcomes in Acne. J. Am. Acad. Dermatol 49:S1.
2. **Bronsnick T., Murzaku E.C., and Rao B.K., (2014):** "Diet in dermatology: Part I. Atopic dermatitis, acne, and nonmelanoma skin cancer". JAAD.71 (6): e1–1039.e12.
3. **Gamble R., Dunn J., Dawson A. et al., (2012):** "Topical antimicrobial treatment of acne vulgaris: an evidence-based review" Am. J. Clin. Dermatol.13 (3): 141–52.
4. **Riahi R.R., Bush A.E. and Cohen P.R., (2016):** "Topical Retinoids: Therapeutic Mechanisms in the Treatment of Photodamaged Skin". Am. J. Clin. Dermatol. 17 (3): 265–76.
5. **Walsh T.R., Efthimiou J. and Dréno B., (2016):** "Systematic review of antibiotic resistance in acne: an increasing topical and oral threat".Lancet Infect. Dis.16 (3): e23–33.
6. **ArowojoluA.O., Gallo M.F., Lopez L.M. et al., (2012):** "Combined oral contraceptive pills for treatment of acne". Cochrane Database of Systematic Reviews (Systematic Review & Meta-Analysis). **7** (7): CD004425.
7. **Pugashetti R. and Shinkai K., (2013):** "Treatment of acne vulgaris in pregnant patients".DERMATOL THER.26 (4): 302–11.
8. **Madan R.K. and Levitt J., (2014):** "A review of toxicity from topical salicylic acid preparations". JAAD.70 (4): 788–92.
9. **Brandt Staci, (2013):** "The clinical effects of zinc as a topical or oral agent on the clinical response and path. ophysiologic mechanisms of acne: a systematic review of the literature". Journal of Drugs in Dermatology: JDD. 12 (5): 542–5.
10. **Zeichner J., (2011): "**Strategies to minimize irritation and potential iatrogenic post inflammatory pigmentation when treating acne patients with skin of color". J. Drugs Dermatol. 10(12):S25-6.
11. **Bolognia J.L. and Jorizzo J.L., (2008):** Dermatology (2nd edition ed.). St. Louis, Mo.: Mosby Elsevier.
12. **Lee S.J., Goo J.W., Shin J. et al., (2012):** "Use of fractionated microneedle radiofrequency for the treatment of inflammatory acne vulgaris in 18 Korean patients". Dermatol Surg.; 38(3):400–5.
13. **Ong M.W.S. and Bashir S.J., (2012):** "Fractional laser resurfacing for acne scars: a review". BJD.166 (6): 1160–9.

ISSN:0975-3583,0976-2833 VOL12,ISSUE05,2021

14. **Seaton E.D., Charakida A., Mouser P.E. et al., (2003):** "Pulsed-dye laser treatment for inflammatory acne vulgaris": randomised controlled trial. Lancet. 362(9393):1347–52.
15. **Darné S., Hiscutt E.L. and Seukeran D.C., (2011):** "Evaluation of the clinical efficacy of the 1,450 nm laser in acne vulgaris": a randomized split-face, investigator-blinded clinical trial. Br. J.Dermatol. 165(6):1256–62.
16. **Zaleski-Larsen L.A. and Fabi S.G., (2016):** "Acne Scar Treatment": A Multimodality Approach Tailored to Scar Type. Dermatol. Surg., 42:S13949.
17. **Ghersetich, BrazziniB., and LottiT., (2003):** "Chemical peeling," in European Handbook of Dermatological Treatments, T.M. Lotti and A.D. Katsambas, Eds., Springer, Berlin, Germany, 2nd edition.
18. **Bernstein E.F., Lee J., Brown D.W. et al., (2001):** "Glycolic acid treatment increases type I collagen mRNA and hyaluronic acid content of human skin", Dermatologic Surgery, vol. 27, no. 5, pp. 429–433 .
19. **Slavin J.W., (2004):** "Trichloroacetic acid peels", Aesthetic Surgery Journal, vol. 24, no. 5, pp. 469–470, 2004.
20. **Imayama S., Ueda S. and Isoda M., (2000):** "Histologic changes in the skin of hairless mice following peeling with salicylic acid", Archives of Dermatology, vol. 136, no. 11, pp. 1390–1395.
21. **Ramos-e-Silva M. and Carneiro S.C., (2009):** "Acne vulgaris: Review and guidelines". Dermatology Nursing/Dermatology Nurses' Association .21 (2): 63–8; quiz 69.
22. **Gould R. and Gordon (1959):** "The LASER, Light Amplification by Stimulated Emission of Radiation". In Franken, P.A.; Sands R.H. (Eds.). 15 June through 18 June 1959.The Ann Arbor Conference on Optical Pumping, the University of Michigan,. p. 128.
23. **Coen B., BaurJ., and Gerone R., (2016):** "Acne scarring: a review of available therapeutic lasers"LASER SURG MED.; 48:95-115.9.
24. **Majid I. and Imran S., (2014):** "Fractional CO2 laser resurfacing as monotherapy in the treatment of atrophic facial acne scars". J CutanAesthet Surg.; 7(2):87–92. doi:10.4103/0974-2077.138326
25. **Friedman P.M., (2004):** "Treatment of atrophic facial acne scars with the 1064-nm Q-switched Nd:YAG laser: Six-month follow-up study". Arch Dermatol, 140(11):1337–1341.
26. **Kuo Y.R., Wu W.S., Jeng S.F. et al., (2005):** "Activation of ERK and p38 kinase mediated keloid fibroblast apoptosis after flashlamp pulsed-dye laser treatment", Lasers in Surgery and Medicine, vol. 36, no. 1, pp: 31–37.
27. **Riveria A.E, (2008):** "Acne scarring: A review and current treatment modalities." J Am AcadDermatol 59:659-76.Disease Primers: 15033.
28. **Bellew S.G., Lee C., Weiss M.A. et al., (2005):** "Improvement of atrophic acne scars with a 1,320 Nm Nd:YAG laser": Retrospective study. Dermatol. Surg., 31:1218-1222.
29. **Yariv and Amnon, (1989):** Quantum Electronics (3rd ed.). Wiley. pp: 208–11.
30. **Walter K.,(1965):"** Solid-state lase engineering".,SpringerVerlag, p: 507.
31. **Jacob C.I., Dover G.S. and Kaminer M.S., (2001):** "Acne scarring: a classification system and review of treatment options". J. Am. Acad. Dermatol.; 45:109-117.
32. **Keller R., Junior W.B., Valente Y. et al., (2007):** "Non-ablative 1,064-nm Nd:YAG laser for treating atrophic facial acne scars: Histologic and clinical analysis". Dermatol. surg., 33:1470-1476.
33. **Goldberg D.J. and Silapunt S., (2001):** "Histologic evaluation of a Q-switched 50. Nd: YAG laser in the non ablative treatment of wrinkles". Dermatol Surg. ; 27: 744 – 746.
34. **Akaishi S., Koike S., Dohi T., et al., (2012):** "Nd:YAG laser treatment of keloids and hypertrophic scars".Eplasty, 12, pp.e1-e1
35. **Khater S., Abd El-kader A., El-Harras M., et al., (2008):** "Laser resurfacing of some cutaneous disorders", Dermatology and Venereolgy department, Faculty of Medicine, Zagazig University.
36. **Ancona D. and Katz B.E., (2010):**"A prospective study of the improvement in periorbital wrinkles and eyebrow elevation with a novel fractional CO2 laser--the fractional eyelift". J. Drugs Dermatol. 9(1):16-21.
37. **Kenneth B.,(2006):** Laser Safety Management.Med. J. Aust., 185(4), 199-202.