

The use of the Erbium Yag Laser in the Treatment of Acne Scar for Female Patients

Hanaa Hasan Kadhim^a, Ali Kamel Mohsin^b, Murtadha Hashem Raheem^c

^aSumer University, College of Medicine, Iraq. E-mail: h.kadhim@uos.edu.iq

^bWaist University, College of Science, Iraq. E-mail: aalbedary@uowasit.edu.iq

^cUniversity of Kufa, College of Medicine, Iraq. E-mail: sumer56ameen@gmail.com

Article History: Received: 11 January 2021; Revised: 12 February 2021; Accepted: 27 March 2021; Published online: 10 May 2021

Abstract: Er: YAG laser wavelength (2940nm) was used of treatment acne scar to different type. there are many different characteristic, which related to the skin layer, such as the stimulated of the skin. The presented article discusses the technical aspects of the utilization of the Er: YAG laser, its preferential utilization has been most common in the dermatology areas, as well as the possible and side effects and hazards. Below are the photographs of the patients under this study before and after Er: YAG acne scar skin resurfacing. All of the patients had mixed trophic acne scar types, which include the boxcar, ice pick, and rolling scars, even though, some certain type is predominating, which is why, it is utilized for the classification of patients in accordance. The difference in the protocols of treatment in addition to the scales of the evaluation that are utilized for the determination of the acne scarring severity in numerous clinical trials have made it difficult comparing the effectiveness of the variety of the fractional lasers that exist for treating the acne scars. In addition to that, studies that investigate the role of Erbium: YAG laser as the main choice in treating the atrophic acne scars are quite limited. which included 12 patient aged 18-25 years with the atrophic facial acne scars with Er: YAG laser. The acne scarring is one of the common dermatological conditions, causing cosmetic and psychological problems.

Keyword: Erbium Yag Laser, Treatment, Acne Scar, Female Patients.

1. Introduction of Laser History

In the present day, the role of laser has been used in many fields such as science, medicine, technological labs, and checkouts of the supermarket and telephone network. The short form of Light Amplification by Stimulated Emission of Radiation is LASER. The laser beam was first discovered by Theodore Maiman in 1960, as it pumped with xenon flash lamp [1].

The laser was a system used to generate a high density, outwardly parallel beam of monochromatic (one wavelength) electromagnetic radiation. In 1917, Albert Einstein expected the possibility of stimulated emission. Based on the work of Gordon in 1955, Schawlow and Townes developed ruby laser beam emitting shiny red light in 1958. This was followed within three years through the development of the carbon dioxide (CO₂), argon and (Nd: YAG) laser that was still used in medicine[2].

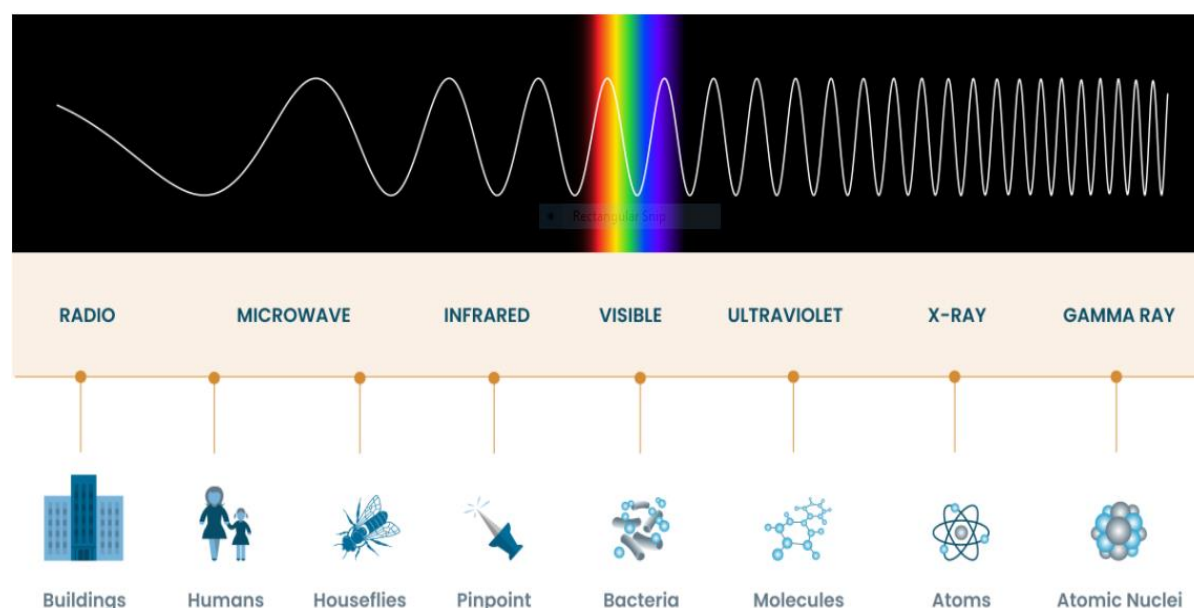


Figure 1. Electromagnetic spectrum

The laser is considered as "a solution looking for a problem" [3]. The character of lasers can be defined as a focused and a source of monochromatic light, and it has a high output that has presented photonics revolution[4].

There are various types of laser wavelength have been expanded over the years with many varieties. There were a massive number of photon sources that now represent laser wavelength. The electromagnetic spectrum has been depicted in figure (1). The role of laser has been extended in X-ray and UV light from nanometers to the wavelength in millimetres. The different specific wavelength lasers have been extended to longer and shorter wavelengths, and thus, expanded the spectral coverage[5].

2. ER: YAG Laser

Erbium laser, which involves an active medium of crystal or glass, depending on its use, is a solid-state lasers' type. The crystal is yttrium aluminium garnet ($Y_2AL_5O_{12}$), in addition to the goblet is any phosphate or else silicate. E. Snitzer and R. Woodcock created the Er: glass in 1961 at American Optical Company, and the material used in this glass is Yttrium aluminium. The Soviet scientists created the Er: YAG in 1975, and either phosphate or silicate was used as its material [6].

Those inventors found out that Er: lasers is able to send out undetectable beam in mid-infrared range of electro-magnetic spectrum by placing erbium ions as host crystal in place of the neodymium ions [7].

There are two wavelengths, which are obtained by the active medium of the Er laser. The first one is the 1540 nm in case of the phosphate glass and the second one is the 2940 nm in the case of ($Y_3AL_5O_{12}$) crystal. Thus, here are crucial usages for Erbium laser's wavelengths. For example, the optical communications, military and positions, whereas the other wavelength (2940)nm is used for medical issues.

On the one hand, the Er: laser is similar to ND: YAG laser in the case of that water has been considered as the strong absorber meant for the laser light. In addition to that, this operating systems can be either continuous wave (CW) or pulsed one[8]. Er: lasers are different from YAG lasers concerning the pumping source that can be semiconductor laser, lamp and flash (InGaAS).

Broadly speaking, there are particular properties for the Er: YAG, which are identified as follows:[9,10].

- Outstanding optical eminence.
- Elevated effectiveness.
- Little spreading.
- Lengthy-wavelength.
- broad drive range (600-800)nm.
- Decreased collagen dwindling.
- Low thermal harm toward the nearby region of the objective.
- Elevated verge of the laser function.
- Ablative laser.
- Little saturation deepness.

Er: glass laser in additional has the following features:[11].

- Comparatively safe.
- MPE is more than further lasers.
- Non-ablative laser.
- Elevated threshold laser.
- Full drive range (900-1000)nm.

Skin Anatomy

The skin is the largest body organ, it makes up approximately 15% of the entire adult body weight, it can perform numerous important functions, which include protecting from the external chemical, biological, physical assailants in addition to preventing excess water loss from body and the impact of the thermo-regulation[12].

Layers of Skin

The skin includes 3 layers as can be seen from figure 2:-

- Epidermis.
- Dermis.
- Subcutaneous tissue.

The outmost layer is epidermis which includes certain constellation of keratinocyte cells, functioning to the synthesis of the keratin, along thread like protein with the protective roles. The dermis is middle layer, which is mainly made up of the fibrillar structural protein, which is referred to as the collagen. Dermis lies on subcutaneous tissue, which contains small lobes of the flat cells that have been referred to as the Lipocytes. Those layers' thickness is considerably varying according to the geographical location in a body. Ex: eye lid is thinnest epidermal layer. Palm and sole have the thickest epidermal layer [12].

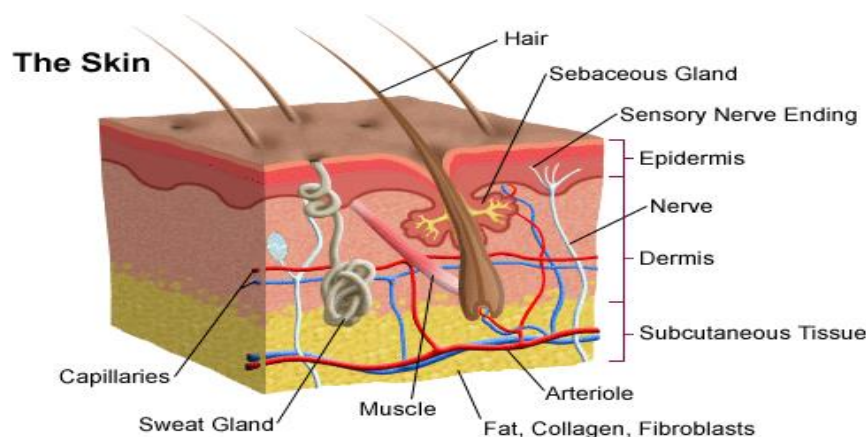


Figure 2. Anatomy of the Skin[13]

Skin Type

The optimal candidates for the laser re-surfacing have fair skin of Fitzpatrick type I to type III (Table 1). any patient can be a candidate for the laser re-surfacing for laser resurfacing, regardless of skin color. Patient with fair skin (type I and III) and with thick, sebaceous skin have higher likelihood of having prolonged erythema [14].

Table 1. Type (I,II,IV, V,VI)[14]

Type I	Type II	Type III	Type IV	Type V	Type VI
White Skin. never tans, Always burns,	Fair skin Always, tans with difficulty.	Average colour of the skin. Mild burn in some cases, tan nearly average.	Light brown colour. Seldom burns. Tans quite easily	Brown skin. Tans quite easily. Never burns.	Heavily pigmented Black skin. Tans very easily Never burns

Acne Scarring

Acne vulgaris has been considered as a multi-factorial chronic inflammatory skin disorder, which is associated with various environmental as well as genetic factors in the portions of sebaceous gland. The clinical impact of the disease can drastically vary from a mild comedonal stage to a fulminant impact of the disease. This disease commonly affects all categories of aged people, but the people in the adolescent stage are more prone to infection [15].

Scarring is an event that occurs during the impact of abnormal vibrations or the healing stage, which happens in the sebaceous hair follicle during the impact of inflammation[16]. Scarring is a deep mark indicating an abnormal inflammatory lesion, but it happens commonly in the dermal and hypodermal regions for all patients[17].

Even with the available highly efficient treatment procedures, scarring can commonly occur. Which might be prominent and result from a cystic acne type, even though smaller lesions could result in the production of the scarring in a few individuals [18].

1-7 Types of Acne Scars

Acne scars may exist in multiple forms like,

- A. Superficial macular scars:** This type of scar occurs in the regions of the epidermal and superficial dermal layer in the form of discolored erythematous macules. They do not undergo any form of thickenings in the surface layer of the skin. Additionally, these scars appear to be inflamed and cause damage to the skin associated with modified pigmentation skin disorders [14].
- B. Ice pick scars:** These scars usually appear in a cone shape and are considered to be sharp, pointed, narrow (>2 mm) range prolonging to the marginal regions of the epithelial tract that continues vertically in the regions of dermal and subcutaneous tissue layers. The damaged surface opening does not appear more spacious than the funnel-shaped infundibulum as the ice pick scars elongate from the surface layer to its extreme possible spot[19, 20] as represented in Figure (3).



Figure 2. Type acne scar



Figure 3. Type acne scars

- C. Rolling Scars:** This type of scar appears in a wavy fashion, which commonly occurs in the regions of dermal and epidermal regions of the skin. These scars appear in a wide diameter ranging from more than 4 to 5 mm. Anchoring fibrils in the form of collagen VII molecules usually look abnormal in the dermal-epidermal linkage directing to the rolling or swelling appears in the skin layer [21,22] as represented in Figure (2,3).
- D. Boxcar Scars (Chickenpox Scar-like):** These scars appear in the form of depressions like round continued to oval in shape associated with a pointed vertical edge, which looks similar to scars appearing

during varicella infections. These scars look more exhaustive than the ice pick scars at the dermal layer of the skin but clinically does not taper to a deep portion inside the skin layer. Hence, they might exist in various forms comprising shallow range (0.1mm-0.5mm) or deep-tapered (>0.50mm) or most commonly exist in diameter of 1.5 to 4 mm [21,22] as represented in Figure (2,3).

- E. Hypertrophic Scars:** These scars appear like other tissues formed, but they are restricted within the marginal layer of the damaged region. These are considered to be most prevalent during the initial period, and there may be an existence of remission occurring spontaneously in the event of post-injury in figure (2,3) [23].
- F. Keloids:** Keloids commonly protrude from the original injured regions with the overgrowth of tissues that lead to the deposition of excess collagen VII molecules in marginal layers of dermal-epidermal regions of the skin. These keloids usually appear on the shoulders, ears, back and chest in various sizes and might be infectious even after wound healing. The scars which appear due to these keloids might not disappear for a long duration or even lifetime. These keloids are not gender-specific, but it is less commonly visualized in the young aged and old aged people. There might be an influence of genetic inheritance, symbolizing both dominant and recessive characters in autosomal mode in figure (2,3) [24].

3. Dissuasion

Now days of skin rejuvenation can be defined as one of the significant elements of the area of the cosmetic surgery. This study done in researches Uite, Medicine College, Kufa Univ. The objective of the skin resurfacing is removing the damaged upper dermis and epidermis and promoting the formation of new, undamaged dermis and epidermis and resurfacing skin through the removal of skin scar shoulders and creating a new smooth skin surface. The optimal skin resurfacing approach is an approach which has the ability of accurately removing the abnormal dermis and epidermis as well as precisely determining the depth. Reliability and safety are significant criteria as well in the case of comparing various skin remodeling methods. Acne scarring is one of the most common dermatologic conditions, causing cosmetic and psychological issues. There have been numerous modalities proposed for the treatment of the acne scars; which include the surgical methods (punch excision, subcision and punch graft), methods of resurfacing (such as ablative laser treatment, dermabrasion and chemical peeling), autologous fat transfer, non – ablative laser treatments, and dermal filler injections. None-the-less, acne scars remain one of the most prominent therapeutic challenges for the dermatologists.

References

1. Sardana, K. and V.K. Garg, *Lasers in Dermatological Practice*. 2014: JP Medical Ltd.
2. Goldenberg, G., et al., Eruptive squamous cell carcinomas, keratoacanthoma type, arising in a multicolor tattoo. *Journal of cutaneous pathology*, 2008. 35(1): p. 62-64.
3. Al-Dhalimi, M. and A. Jaber, Treatment of atrophic facial acne scars with fractional Er: Yag laser. *Journal of Cosmetic and Laser Therapy*, 2015. 17(4): p. 184-188.
4. Boas, D.A., C. Pitris, and N. Ramanujam, *Handbook of biomedical optics*. 2016: CRC press.
5. Svelto, O. and D.C. Hanna, *Principles of lasers*. Vol. 1. 2010: Springer.
6. Koechner, W., *Solid-state laser engineering*. Vol. 1. 2013: Springer.
7. Herman, R. and D.R. Boboescu, *Characteristics of Laser Beam Used in Materials Processing*.
8. Koechner, W. and M. Bass, *Solid-State Lasers: A Graduate Text*, 314 Springer Verlag. New York, 2003.
9. Rao, M., Applications of CO2 laser in medicine. *Int. J. Adv. Pharmacy, Biol. Chem.*, 2013. 2(3): p. 501-506.
10. Weinzwieg, J., *Plastic Surgery Secrets Plus E-Book*. 2010: Elsevier Health Sciences.
11. Denker, B. and E. Shklovsky, *Handbook of solid-state lasers: materials, systems and applications*. 2013: Elsevier.
12. Baldi, A., P. Pasquali, and E.P. Spugnini, *Skin cancer: a practical approach*. 2013: Springer Science & Business Media.
13. Lang, F., G.L. Busch, and H. Völkl, The diversity of volume regulatory mechanisms. *Cellular Physiology and Biochemistry*, 1998. 8(1-2): p. 1-45.
14. Goodman, G.J., Management of post-acne scarring. What are the options for treatment? *American journal of clinical dermatology*, 2000. 1(1): p. 3-17.
15. Ahmad, S., et al., *Efficacy and safety of oral azithromycin in the treatment of mild to moderate acne vulgaris*. Annals of King Edward Medical University, 2011. 17(4): p. 437-437.
16. Layton, A., *Disorders of the sebaceous glands*. Rook's textbook of dermatology, 2010. 1: p. 1-89.
17. Simpson, N.B. and W.J. Cunliffe, *Disorders of the sebaceous glands*. Rook's textbook of dermatology, 2004: p. 2121-2196.

18. James, W.D., T.G. Berger, and D.M. Elston, Acne. Andrews' Diseases of the Skin. *Clinical Dermatology*, 10th ed. Philadelphia, PA: Saunders/Elsevier Inc, 2006: p. 231-250.
19. Jacob, C.I., J.S. Dover, and M.S. Kaminer, Acne scarring: a classification system and review of treatment options. *Journal of the American Academy of Dermatology*, 2001. 45(1): p. 109-117.
20. Jemec, G.B. and B. Jemec, Acne: treatment of scars. *Clinics in dermatology*, 2004. 22(5): p. 434-438.
21. Alestas, T., et al., Enzymes involved in the biosynthesis of leukotriene B 4 and prostaglandin E 2 are active in sebaceous glands. *Journal of molecular medicine*, 2006. 84(1): p. 75-87.
22. Makrantonaki, E. and C. Zouboulis, Testosterone metabolism to 5 α -dihydrotestosterone and synthesis of sebaceous lipids is regulated by the peroxisome proliferator-activated receptor ligand linoleic acid in human sebocytes. *British Journal of Dermatology*, 2007. 156(3): p. 428-432.
23. Rivera, A.E., Acne scarring: a review and current treatment modalities. *Journal of the American Academy of Dermatology*, 2008. 59(4): p. 659-676.
24. Nagy, I., et al., Propionibacterium acnes and lipopolysaccharide induce the expression of antimicrobial peptides and proinflammatory cytokines/chemokines in human sebocytes. *Microbes and infection*, 2006. 8(8): p. 2195-2205.