

# Applied Lasers in Acne Scar Treatment: A Brief Review

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**Abstract:** *Introduction:* Scar of Acne is a prevalent condition that may lead negative impact on the patients' quality of life and is frequently might be worsened by aging. A number of options are available for the treatment of acne scarring, including retinoid, microdermabrasion, dermal fillers, and surgical techniques such as subcision. The aim of this study is to review the different laser modalities that have been applied in clinical studies for treatment of acne scars, and summarize current clinical approaches.

*Methods:* A Medline search spanning was performed on acne scarring. Search terms included "atrophic acne scars," "ablative", "non-ablative," "fractional," "non-fractional," "neodymium," "alexandrite," "pulsed dye" lasers, and results are summarized.

*Results:* Various types of lasers have been evaluated for the treatment of atrophic acne scars. While they are efficacious overall, they differ in terms of side effects and clinical outcomes, depending on patients' skin and acne scar type. A new emerging trend is to combine lasers with other energy-based devices and/or topical.

*Conclusions:* Evaluation of the literature examining acne scar treatment with lasers revealed that clinical outcomes are dependent on various patient factors, including atrophic acne scar subtype, patient skin type, treatment modality, and side-effect profile.

**Keywords:** Acne, Scar, Laser therapy.

## INTRODUCTION

Lesions caused by the obstruction of sebaceous gland duct in the face, neck, back, shoulders and chest are called pimples or so-called acne [1-3]. These lesions can occur in the form of blackheads, whiteheads, pustules, cysts and nodules. Acne or pimple is a skin disorder that occurs during adolescence and persists until the end of the youth period. Acne can be seen in most teens and remain by the end of youth age and even in those aged above thirty years. Pimples usually heal after a few years, but you can't ignore them because even if some pimples heal, the subsequent scar would remain until the end of life that is aesthetically problematic [1-5]. Although these scars can be repaired, however in some cases, they are potential to reduce life quality of the persons due to mental bothering. So, it is better to treat the pimple rather than to treat the resulting scar later. Acne is easier and faster to treat and the results are more satisfactory [1, 6, 7]. While treating acnes, it should be noted that each skin has its own medication and a single drug therapy cannot be used to treat all skin

types, so it is vitally important to visit a specialist. As mentioned above, one of the major complications of acne is its resulting scarring, which can cause discomfort in the person until the end of life [1, 3, 8]. Fortunately, today, with the advancement of laser technology, numerous treatments are available along with different devices to treat acne scar that can significantly improve the appearance of individuals with an acne scar. The dermatologist is the person who decides on the type of device used to treat and the number of sessions [9-11].

## TYPES OF ACNE SCAR

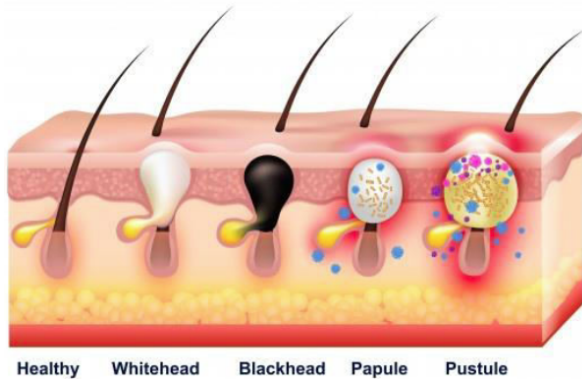
Acne can be mild, moderate, or severe. As it can be seen in the Figure 1, mild acne causes less irritated whiteheads or blackheads with or without a few red bumps or pustules. But severe acne, especially cystic acne, is likely to leave permanent scarring as it heals. Most of the time the light red or brown marks left behind by healed acne clears up over time on their own.

There are some classes of acne scars according to the available classifications. Table 1 summarizes the types of scars. Acne-induced scarring depends on three factors: severity of facial pimples, family history of

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acne scars, and duration of acne before treatment [1,11-12].

**TYPES OF ACNE PIMPLES**



**Figure 1:** Skin Acne.

The more severe the facial pimple is, the more likely the scar will develop. Scars are seen in almost 100% of raised and cystic acne. Some people are prone to scarring in the family, which means that the scarring remains in other family members after creation of a wound or skin lesion. These patients are more at risk of scarring due to facial pimples. The later a person begins to cure his/her illness, the more likely the risk of acne scars will be. If the person does not take any acne treatment measure for more than three years, the chance is greatly increased. This highlights the need for rapid treatment for facial pimples. Basically, acne scars are divided into raised and depressed groups. Different methods are used to treat scars caused by facial pimples [12-15].

**Table 1: Types of Scar**

Scar acne	Description
Superficial macular scar	It occur in epidermis and dermis surface as pigments in macula and erythema
Ice-Pick scar	Conical scar, with a upper wide surface area extending toward the reticulum
Rolling scar	Wavy form, there is a defect in the dermo-epidermal grafts due to subcutaneous fat injury
Boxcar scar	The oval form, the surface diameter is greater than the depth
Hypertrophic scar	Overgrowth of scar margins
Keloid	Excessive extra tissue outside the scar border

**TREATMENT USING LASERS**

There are several laser treatments for acne scar: excision, punch excision, subcision, dermabrasion,

chemical peeling, ablative microdermabrasion, ablative invasive lasers, non-ablative non-invasive lasers, fractional lasers schematically shown in Figure 2 [1, 5, 12-16].

Laser systems used to treat acne scars are divided into three categories. Brief information of each category is summarized as below:

**Category 1**

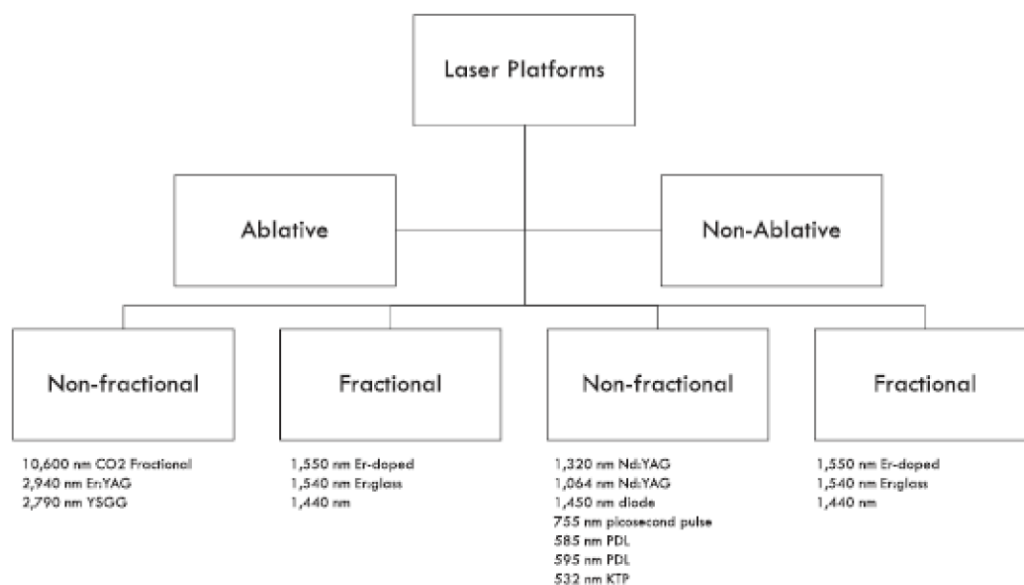
It consists of carbon dioxide lasers and erbium lasers. These lasers are often used to treat acne-induced sunken lesions. These lasers remove superficial layers of skin with micron precision and stimulate the lower parts of the skin to produce collagen and thereby treating scarring. Numbing creams are used before using these lasers that make the laser treatment less painful. The treated site is usually red up to a few days, which can be improved by doctor-recommended care and the use of skin regeneration creams. Improvement of acne scars in this method takes an average of three laser sessions for one to three months [10-19].

**Category 2**

These are non-destructive Pulsed Dye Lasers (PDLs) used in the treatment of acne scars. These lasers make changes in the lower skin layers by preserving the upper layers and are usually used to treat acne-induced raised and red scars and do not require preoperative numbness [5, 20-24].

**Category 3**

There are a new generation of lasers known as fractional lasers used in the treatment of scar acne [1, 10, 16]. These lasers, which have been on the market for several years, work by destroying a small portion of the skin but leaving most of it intact. This allows the intact part of the skin to quickly heal its damaged part. This technology reduces the complications of destructive lasers and help the patient go back to his work faster, but requires more sessions in order to achieve therapeutic effects [15-16]. Fractional CO2 laser is a highly advanced technology in the treatment of acne scars; pimples, burns, pores, skin cracks; skin rejuvenation and tightening that are common seen in today's society. Since most clients are employed or university students and can't cover or dress their faces with a conventional Co2 laser for several weeks, it is a very acceptable method to treat a variety of skin lesions including rejuvenation, removing scars, acne,



**Figure 2:** Various therapeutic Lasers for Acne scar.

burns or surgery, and skin cracks that is almost not painful and requires no rest or dressing [10, 15, 26-31]. Fractional Co2 laser is a modified Co2 laser that does not have the side effects of a conventional Co2 laser but we can use its good advantages in treating the following lesions. The fractional Co2 laser is used to treat the following lesions [29-31]:

- Moderately deep and deep wrinkles
- Scarring (skin fossa), or acne
- Skin aging
- Scarring from burns or cuts
- Postoperative scars
- Open skin pores
- Skin tightening
- Eyelid wrinkles
- Abdominal and body skin cracks
- Aging-induced spots

#### **Differences between a Conventional Co2 Laser and a Fractional Co2 Laser**

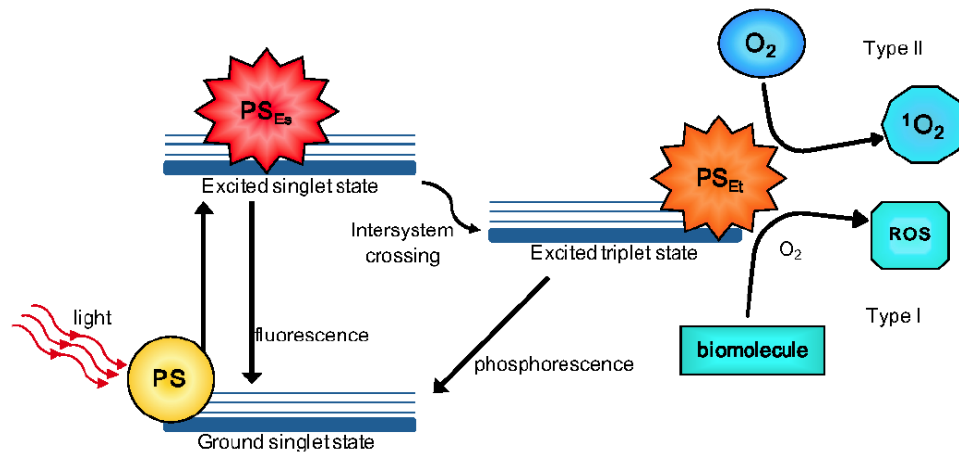
A fractional Co2 laser, unlike a conventional Co2 laser, requires no anesthesia or numbing medication. The patient can only be laser treated with a numbing cream with minimal discomfort [10, 11].

Also, unlike the conventional Co2 laser, the patient does not require dressing in this new fractional Co2

method and only uses skin regeneration creams and watch out for sunlight. Fractional Co2 skin regeneration takes between 6 and 10 days, whereas it takes between 2 and 3 weeks in the case of conventional Co2 lasers. In fractional method, the patient's skin is red only for 6 -10 days, whereas the redness can persist for 2-6 months in a conventional Co2 laser. Skin darkening is a rare event in in a fractional Co2 laser. Fractional co2 lasers can also be used on the neck and back of the hands or other parts of the body to treat a variety of skin lesions such as rejuvenation of the back of hands, skin spots, abdominal cracks, and burn or surgery scars [10, 23-31].

#### **Fractional Erbium Laser**

Fractional Erbium 2940 nm Laser is the newest laser in the treatment of facial wrinkles, open pores, acne scars, and face whitening. If you want to achieve a better understanding of the mechanism and effects of this laser, it's best to consider it as rival of the fractional CO2 laser, because its mechanism of action is very similar to fractional or fractional CO2 lasers. The only difference between Erbium 2940 and fractional CO2 laser includes its more invasive nature, less radiation penetration into the skin, fewer complications and less heat-induced skin damage, lower post-laser therapy burns, faster skin regeneration, so, it is subdivided into semi-invasive lasers (compared to fractional CO2). Therefore, it is better to use the above laser instead of the fractional CO2 laser for different treatments in the case of sensitive skins as well as on sunny days [16, 26]. Ultimately, this is an experienced physician who decides what type of device to use and for which skin



**Figure 3:** Photodynamic therapy schematics and elements.

type (sensitive or non-sensitive- light or white to light brown or dark skin).

### Photodynamic Therapy in the Treatment for Acne Scars

Photodynamic therapy (PDT)<sup>1</sup> is an effective, fast, and non-toxic light-based procedure. Photodynamic therapy requires three components: a photosensitizer, a light source, and reactive oxygen species.

Photosensitizers are typically applied solutions that cause certain types of abnormal cells to produce light-absorbing molecules called porphyrins. This change allows the light treatment to target the abnormal cells that are contributing to the acne. The use of photosensitizers distinguishes PDT from other forms of phototherapy [32].

After applying a photosensitizer mostly a topical one or either systemic intake, a medical light source is focused on the skin to activate it. This light source may provide blue light, red light, or intense pulsed light<sup>2</sup> [32]. It is selectively absorbed by cancer and malignant cells and activated by appropriate laser or LED<sup>3</sup> light [33]. These substances include photofrin, porphyrin, Aminolevulinic acid<sup>4</sup>, methylene blue, toluidine blue, curcumin, and so on. Radiation-induced activation of these substances leads to a release of free radicals, which are lethal to target cells. Photosensitizers may be administered orally or injected, and the interval between drug use and treatment varies from minutes to several days depending on the substance and the

tumor. This treatment is used to treat skin, head and neck, esophageal, stomach, lung, and bladder cancers and is being studied in the treatment of cancers such as prostate and pancreatic cancers. Photodynamic therapy has advantages over other effective cancer treatments such as surgery, radiotherapy, and chemotherapy, which include high operative speed, better effect on target tissue compared to surgery, less invasive property, less annoying side effects compared to radiotherapy, and chemotherapy [33].

5-ALA cream is rapidly applied to the skin and absorbed by hair follicles, adipose tissue, and growth bacteria or cells during the photodynamic laser therapy for acne scars. Light irradiation (Red light, IPL) results in damage to the target tissue, a decrease in number of the bacterium on the skin, and a decrease in the fat concentration in the producing glands, which ultimately improves the acne symptoms [34-37].

In summary, the therapeutic results of the use of 5-ALA creams with laser irradiation appropriate to the absorption peak of this photosensitizer in clinical studies have shown the efficacy of photodynamic therapy for acne scars. In addition, few therapeutic side effects have been reported in patients undergoing this treatment [36].

### CONCLUSION

Laser and light based systems in particular have a key role in the management of acne scarring, which tends to be refractory to medical therapies. Fractional photothermolysis, the 1450-nm diode laser, and pulsed dye lasers have been used in the non-ablative treatment of acne scars as there have been reported significant success for such novel treatment approaches in compare to the conventional ones.

<sup>1</sup>Photodynamic therapy: PDT

<sup>2</sup>intense pulsed light: IPL

<sup>3</sup>Light Emitting Diode: LED

<sup>4</sup>Aminolevulinic acid :ALA

## REFERENCES

- [1] Sadick NS, Cardona A. Laser treatment for facial acne scars: A review. *Journal of Cosmetic and Laser Therapy* 1476-4172 (Print) 1476-4180.
- [2] Goulden V, Stables GI, Cunliffe WJ. Prevalence of facial acne in adults. *J Am Acad Dermatol* 1999; 41(4): 577-80. [https://doi.org/10.1016/S0190-9622\(99\)70300-2](https://doi.org/10.1016/S0190-9622(99)70300-2)
- [3] Oberemok SS, Shalita AR. Acne vulgaris, I: pathogenesis, and diagnosis. *Cutis* 2002; 70: 101-105.
- [4] Layton AM, Henderson CA, Cunliffe WJ. A clinical evaluation of acne scarring and its incidence. *Clin Exp Dermatol* 1994; 19 (4): 303-08. <https://doi.org/10.1111/j.1365-2230.1994.tb01200.x>
- [5] Babilas P, Schremel S, Eames T, Hohenleutner U, Landthaler M, Hohenleutner S. Experience with non-ablative fractional photothermolysis with a dual-mode laser device (1,440/1,320 nm): no considerable clinical effect on hypertrophic/acne scars and facial wrinkles. *Lasers Med Sci* 2011; 26(4): 473-79. <https://doi.org/10.1007/s10103-011-0893-2>
- [6] Akaishi S, Koike S, Dohi T, Kobe K, Hyakusoku H, Ogawa R. Nd: YAG laser treatment of keloids and hypertrophic scars. *Eplasty* 2012; 12: e1.
- [7] Fabbrocini G, Annunziata MC, D'Arco V, De Vita V, Lodi G, Mauriello MC, Pastore F, Monfrecola G. Acne scars: pathogenesis, classification and treatment. *Dermatol Res Pract* 2010; 2010: 893080. <https://doi.org/10.1155/2010/893080>
- [8] Jacob CI, Dover JS, Kaminer MS. Acne scarring: a classification system and review of treatment options. *J Am Acad Dermatol* 2001; 45(1): 109017. <https://doi.org/10.1067/mjd.2001.113451>
- [9] Jacob CI, Dover JS, Kaminer MS. Acne scarring: a classification system and review of treatment options. *J Am Acad Dermatol* 2001; 45(1): 109-17. <https://doi.org/10.1067/mjd.2001.113451>
- [10] Magnani LR, Schweiger ES. Fractional CO2 lasers for the treatment of atrophic acne scars: a review of the literature. *J Cosmet Laser Ther* 2014; 16(2): 48-56. <https://doi.org/10.3109/14764172.2013.854639>
- [11] Faghihi G, Nouraei S, Asilian A, Keyvan S, Abtahi-naeini B, Rakhshanpour M, Nilfroushzadeh AM, Hosseini SM. Efficacy of punch elevation combined with fractional carbon dioxide laser resurfacing in facial atrophic acne scarring: a randomized split-face clinical study. *Indian J Dermatol* 2015; 60(5): 473-78. <https://doi.org/10.4103/0019-5154.159616>
- [12] Cohen BE, Brauer JA, Geronemus RG. Acne scarring: a review of available therapeutic lasers. *Lasers Surg Med* 2016; 48(2): 95-115. <https://doi.org/10.1002/lsm.22410>
- [13] Rivera AE. Acne scarring: a review and current treatment modalities. *J Am Acad Dermatol* 2008; 59(4): 659-76. <https://doi.org/10.1016/j.jaad.2008.05.029>
- [14] Wolfram D, Tzankov A, Pulzl P, Piza-Katzer H. Hypertrophic scars and keloids—a review of their pathophysiology, risk factors, and therapeutic management. *Dermatol Surg* 2009; 35(2): 171-81. <https://doi.org/10.1111/j.1524-4725.2008.34406.x>
- [15] Majid I, Imran S. Fractional CO2 laser resurfacing as monotherapy in the treatment of atrophic facial acne scars. *J Cutan Aesthet Surg* 2014; 7(2): 87-92. <https://doi.org/10.4103/0974-2077.138326>
- [16] Min SU, Choi YS, Lee DH, Yoon MY, Suh DH. Comparison of a long-pulse Nd: YAG laser and a combined 585/1064-nm laser for the treatment of acne scars: a randomized split-face clinical study. *Dermatol Surg* 2009; 35(11): 1720-27. <https://doi.org/10.1111/j.1524-4725.2009.01086.x>
- [17] Manuskiatti W, Iamphonrat T, Wanitphakdeedecha R, Eimpunth S. Comparison of fractional erbium-doped yttrium aluminum garnet and carbon dioxide lasers in resurfacing of atrophic acne scars in Asians. *Dermatol Surg* 2013; 39(1 Pt 1): 111-20. <https://doi.org/10.1111/dsu.12030>
- [18] Maluki AH, Mohammad FH. Treatment of atrophic facial scars of acne vulgaris by Q-switched Nd: YAG (Neodymium: yttriumAluminum-Garnet) laser 1064 nm wavelength. *J Cosmet Laser Ther* 2012; 14(5): 224-33. <https://doi.org/10.3109/14764172.2012.723807>
- [19] Orringer JS, Kang S, Johnson TM, Karimipour DJ, Hamilton T, Hammerberg C, Voorhees JJ, Fisher GJ. Connective tissue remodeling induced by carbon dioxide laser resurfacing of photodamaged human skin. *Arch Dermatol* 2004; 140(11): 1326-32. <https://doi.org/10.1001/archderm.140.11.1326>
- [20] Walsh JT Jr., Deutsch TF. Pulsed CO2 laser tissue ablation: measurement of the ablation rate. *Lasers Surg Med* 1988; 8(3): 264-75. <https://doi.org/10.1002/lsm.1900080308>
- [21] Alexiades-Armenakas MR, Dover JS, Arndt KA. The spectrum of laser skin resurfacing: non-ablative, fractional, and ablative laser resurfacing. *J Am Acad Dermatol* 2008; 58(5): 719-37; quiz 738-740. <https://doi.org/10.1016/j.jaad.2008.01.003>
- [22] Zhou BR, Zhang T, Bin Jameel AA, Xu Y, Xu, Y, Guo SL, Wang Y, Permatasari F, Luo D. The efficacy of conditioned media of adipose-derived stem cells combined with ablative carbon dioxide fractional resurfacing for atrophic acne scars and skin rejuvenation. *J Cosmet Laser Ther* 2016; 18(3): 138-48. <https://doi.org/10.3109/14764172.2015.1114638>
- [23] Alajlan AM, Alsuwaidan SN. Acne scars in ethnic skin treated with both non-ablative fractional 1,550 nm and ablative fractional CO2 lasers: comparative retrospective analysis with recommended guidelines. *Lasers Surg Med* 2011; 43(8): 787-91. <https://doi.org/10.1002/lsm.21092>
- [24] Patidar MV, Deshmukh AR, Khedkar MY. Efficacy of Intense Pulsed Light Therapy in the Treatment of Facial Acne Vulgaris: Comparison of Two Different Fluences. *Indian J Dermatol* 2016; 61(5): 545-549. <https://doi.org/10.4103/0019-5154.190115>
- [25] Lee DH, Choi YS, Min SU, Yoon MY, Suh DH. Comparison of a 585-nm pulsed dye laser and a 1064-nm Nd: YAG laser for the treatment of acne scars: A randomized split-face clinical study. *J Am Acad Dermatol* 2009; 60(5): 801-07. <https://doi.org/10.1016/j.jaad.2008.11.883>
- [26] Tanzi EL, Alster TS. Comparison of a 1450-nm diode laser and a 1320-nm Nd: YAG laser in the treatment of atrophic facial scars: a prospective clinical and histologic study. *Dermatol Surg* 2004; 30(2 Pt 1): 152-57. <https://doi.org/10.1111/j.1524-4725.2004.30078.x>
- [27] Oram Y, Akkaya AD. Refractory postinflammatory hyperpigmentation treated fractional CO2 laser. *J Clin Aesthet Dermatol* 2014; 7(3): 42-44.
- [28] Nirmal B, Pai SB, Sripathi H, Rao R, Prabhu S, Kudur MH, Nayak SUK. Efficacy and safety of erbium-doped yttrium aluminium garnet fractional resurfacing laser for treatment of facial acne scars. *Indian J Dermatol Venereol Leprol* 2013; 79(2): 193-98. <https://doi.org/10.4103/0378-6323.107635>
- [29] Lee HS, Lee JH, Ahn GY, Lee DH, Shin JW, Kim DH, Chung JH. Fractional photothermolysis for the treatment of acne scars: a report of 27 Korean patients. *J Dermatolog Treat*. 2008; 19(1): 45-49. <https://doi.org/10.1080/09546630701691244>
- [30] Taylor MB, Zaleski-Larsen L, McGraw TA. Single session treatment of rolling acne scars using tumescent anesthesia,

- 20% trichloroacetic acid extensive subcision, and fractional CO2 laser. *Dermatol Surg* 2017; 43(Suppl 1): S70-S74.  
<https://doi.org/10.1097/DSS.0000000000000895>
- [31] Asilian A, Salimi E, Faghihi G, Dehghani F, Tajmirriahi N, Hosseini SM. Comparison of Q-switched 1064-nm Nd: YAG laser and fractional CO2 laser efficacies on improvement of atrophic facial acne scar. *J Res Med Sci* 2011; 16(9): 1189-95
- [32] Kang WH, Kim YJ, Pyo WS, Park SJ, Kim JH. Atrophic acne scar treatment using triple combination therapy: dot peeling, subcision and fractional laser. *J Cosmet Laser Ther* 2009; 11(4): 212-15.  
<https://doi.org/10.3109/14764170903134326>
- [33] Pei S, Inamadar AC, Adya KA, Tsoukas MM. Light-based therapies in acne treatment. *Indian Dermatol Online J* 2015; 6(3): 145-157.  
<https://doi.org/10.4103/2229-5178.156379>
- [34] Shirkavand A, Babadi M, Najafzadeh E. Laser applications in medical sciences. *Laser in Medicine* 2018; 15(3).
- [35] Jih MH, Kimyai-Asadi A. Laser Treatment of Acne Vulgaris. *Seminars in Plastic Surgery* 21(3): 167-74.  
<https://doi.org/10.1055/s-2007-991185>
- [36] Linkner RV, Jimon S, Haddican M, Singer G, Shim-Chang H. Evaluating the Efficacy of Photodynamic Therapy with 20% Aminolevulinic Acid and Microdermabrasion as a Combination Treatment Regimen for Acne Scarring A Split-face, Randomized, Double-blind Pilot Study. *Clinical Aesthetic* 2014; 7(5).
- [37] Chen X, Song H, Chen S, Zhang J, Niu G, Liu X. Clinical efficacy of 5-aminolevulinic acid photodynamic therapy in the treatment of moderate to severe facial acne vulgaris. *Experimental and Therapeutic Medicine* 2015; 10: 1194-1198.  
<https://doi.org/10.3892/etm.2015.2638>

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