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COMPARATIVE STUDY OF MICRONEEDLING VERSUS ERBIUM YAG LASER IN TREATMENT OF POST ACNE ATROPHIC SCAR

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Abstract

Introduction: Acne vulgaris is a prevalent dermatological condition affecting nearly 90% of adolescents worldwide, often resulting in persistent atrophic scars that significantly impair cosmetic appearance and psychosocial well-being. The pathogenesis of acne scarring remains poorly understood, with individual vulnerability influenced by multifactorial factors. Conventional treatment modalities, including laser resurfacing and microneedling, have demonstrated variable efficacy due to the complex nature of scar formation. This study aims to compare the clinical effectiveness, patient satisfaction, tolerability, and safety profiles of nonablative fractional erbium laser therapy versus microneedling in the management of atrophic facial acne scars. By evaluating these modalities, the research seeks to identify optimal treatment strategies to improve quality of life for affected individuals. **Methodology**: We used a fractional Er: YAG laser and microneedling Patients participated in a total of four sessions, each spaced out by four weeks. First, around half an hour before the treatment, a topical cream containing lidocaine was applied. Each patient had treatment with a fractional Er: YAG laser, which consisted of three passes in alternating vertical and horizontal directions using the basic mode. These passes were as follows: 1 pass Needle depth of 0.8 mm over the forehead and nose, 2.5 mm over the cheeks and chin. **Result**: A prospective interventional study was conducted at the Department of Orthopaedics, Pacific Institute of Medical Sciences, Sai Tirupati Hospital, Udaipur, to compare the efficacy of Erbium YAG laser and microneedling in the treatment of acne scars. A total of 76 patients with acne scars were enrolled and divided equally into two groups: Erbium YAG laser (n=38) and microneedling (n=38). The majority of participants (46.05%) were in the age group of 18–25 years, with a mean age of 26.26 years. Males constituted 65.79% of the study population. Fitzpatrick skin type IV was most common (55.26%), and post-inflammatory hyperpigmentation (PIH) was observed in 46.05% of cases, more frequent in the microneedling group. Ice pick scars were the most prevalent type (84.21%). Improvement in Goodman & Baron (G&B) grading after four sessions was greater in the Erbium YAG group, with 86.85% of patients improving to grade I/II, compared to 71.05% in the microneedling group. Final outcomes showed higher satisfaction in the Erbium YAG group. The study concludes that Erbium YAG laser is more effective than microneedling in reducing acne scars, particularly in patients with Fitzpatrick skin types IV and V, though PIH was slightly more in the microneedling group. **Conclusion**: In conclusions, Atrophic scars are more common in young men aged 20 to 30 years, and men had more atrophic scars than women in both groups. Our study also shows that both treatment Erbium Yag laser therapy and microneedling is effective and efficient in reducing scars, but The Erbium Yag laser was found to be superior to micro needling, and to have a reduction in pain levels and acne scars.

KEYWORDS: *Atrophic scars, Erbium YAG laser, Microneedling, hyperpigmentation.*

INTRODUCTION

Acne is one of the most prevalent skin diseases affecting nearly 90% of adolescents worldwide.1 Acne scars originating from acne are usually the major prolonged concern of patients because they remain permanently. The presence of acne scars can cause severe cosmetic problems as well as psychosocial dysfunction, thereby resulting in huge negative impacts on the patients' quality of life.2Despite the clinical and social significance, the pathogenesis of acne scarring remains mysterious. Interestingly, not all acne patients have acne scars; some are vulnerable to scarring and others are not. Acne scars mainly appear as atrophic shapes, whereas most other scars generally occur in hypertrophic forms.3 Also, several modalities to manage acne scars have shown relatively modest efficacy, reflecting the pathological complexity of acne scars.4These suggest that the development of acne scars may involve unique feature s distinguished from ordinary scar formation. Acne vulgaris is a chronic inflammatory illness of the pilosebaceous unit that is characterised by open and closed comedones coupled with papules, pustules, and nodules of variable degrees of inflammation and depth. Acne vulgaris is the most common form of acne.5

The pathogenesis of acne is multifactorial, including increased biology of the sebaceous gland, increased production of sebum, increased follicular hyperkeratinization, increased proliferation of Propionibacterium acnes (P. acnes), hormonal factors, nutrition, activation of toll-like receptor 2 (tlr-2), many cytokines production, and genetic predisposition.6 Facial acne scars are a frequent consequence of acne vulgaris, which is most often related to delaying treatment. This may further lead to social isolation, a loss of self confidence, and melancholy, which is why effective and safe treatment methods are required.7

There are three different types of acne scars: atrophic, hypertrophic, and keloidal. Atrophic acne scars have been further divided morphologically according to their depth and breadth into rolling, box, and icepick scars, which impacts the choice of treatment strategy. Rolling scars are the most common kind of atrophic acne scar.8 Acne scars have been treated in the past using a wide variety of therapeutic approaches, including medicinal, procedural, and surgical procedures, all of whichhave had varying degrees of success. One method that fits this description is laser resurfacing, which is not only very efficient but also simple to use.

The fractional CO2 and Erbium-YAG lasers have become the gold standard for scar resurfacing due to their efficacy and widespread use. When it comes to water chromophores, the fractional er-YAG laser with a wavelength of 2940 nm is ten times more selective than the CO2 laser.9 Scars left behind by acne are quite common and may have a significant negative effect on a person's quality of life.

Dermatologists have a difficult treatment challenge in a number of situations with this condition.10-12 Several research have been conducted to investigate whether or not the acne scar therapy known as nonablative fractional photothermolysis (NAFP) is effective and whether or not it is safe.13-18 Microneedling (MN) therapy has been widely used as a treatment for various dermatological conditions, including scar tissue.19

Microneedling, also known as percutaneous collagen induction (PCI) or collagen induction therapy, is a minimally invasive technology used for several dermatological conditions. This technique involves repetitive skin puncture using sterile microneedles to disrupt dermal collagen that connects the scar tissue. The needle will penetrate the stratum corneum and generate small holes known as micro-conduits with minimal damage to the epidermis. This process will provoke the regeneration of growth factors to stimulate collagen and elastin production in the lining of dermal blood vessels.20,21 MN can be applied using a range of devices such as manual MN, motorised MN, and radiofrequency coupled.22 The use of MN has been used in the treatment of acne vulgaris, scar tissue, facial rejuvenation, abnormal pigmentation, alopecia, and transdermal drug delivery (TDD).23-25 The benefits of MN as acne scarring treatment was first described by Camirand and Doucet that used a tattoo gun to abrade atrophic scars.26 The primary purpose of this research was to evaluate the efficacy of the nonablative fractional erbium laser in comparison to the effectiveness of the microneedling method for the treatment of atrophic acne scars on the face.

In addition, additional goals included determining the extent to which patients were satisfied with the procedures, as well as determining the methods' levels of tolerance and the number of adverse events they caused.

METHODOLOGY:

AIM AND OBJECTIVES:

AIM: To compare the efficacy of microneedlingvs Erbium yag laser in the treatment of Acne scar.

OBJECTIVES:

- To compare the result of both modality of treatment.
- To compare the complication of both modality of treatment

INCLUSION CRITERIA:

1) New Subjects of Age >18 years with atrophic scar with or without active acne.
2) EXCLUSION CRITERIA:

- Pregnancy
- Patient with any systemic diseases like diabetes, hypertension etc.
- Bleeding disorder or on anticoagulant.
- Autoimmune diseases such as vitiligo, psoriasis, and SLE, active localised or systemic infections • A positive history of keloidal tendency, immunocompromised status.
- Previous treated cases.

The principles outlined in the Declaration of Helsinki were adhered to during the course of this research. Both the Research Ethics Committee and the Institutional Review Board both gave their blessings to proceed with the study. Before beginningthe patient's participation in the research project, we obtained their signed informed permission.

Total 78 patients were taken divided in two groups. One group received Yag Laser and one received Microneddling.

STATISTICAL ANALYSIS:- The data collected during the study was compiled using a Microsoft Excel spreadsheet and analyzed statistically using MedCalc software 22.00. The qualitative data were expressed in numbers and percentages for categorical variables and the quantitative data expressed as mean and standard deviations for continuous variables. The normally and abnormally distributed data difference in mean and median among the groups was analysed mannwhitney u t test. The Chi-square test was used to analyze categorical data among the groups. All results were presented in the form of tables and graphs. A p value of < 0.05 was considered as statistically significant.

OBSERVATIONS AND RESULTS

TABLE 1: COMPARISON OF AGE IN BOTH GROUPS

Age (yrs)	Total no. of patients	Erbium Yag		Micro needling	
		N	%	N	%
18-25	35	20	52.63	15	39.47
26-30	29	13	34.21	16	42.11
31-35	11	4	10.53	7	18.42
36-40	1	1	2.63	0	0.00
Median	26	25		27	
Mean±SD	26.26±3.98	25.94±4.10		26.57±3.88	

Mann whitney u test, P value 0.441 (NS)

Above table depicts, maximum 35 (46.05%) cases were found in the age group of 18-25 years, in which 20 (52.63%) cases in Erbium Yag group and (39.47%) cases in Micro needling group. The mean age was 25.94 years in Erbium Yag group and 26.57 years in Micro needling group. There was a statistically no significant difference in age distribution between the groups.

TABLE 2: COMPARISON OF GENDER IN BOTH GROUPS

Gender	Total no. of patients	Erbium Yag		Micro needling	
		N	%	N	%
Male	50	27	71.05	23	60.53
Female	26	11	28.95	15	39.47
Total	76	38	100.00	38	100.00

Chi square 0.935, P value 0.333 (NS)

In the Erbium Yag group, there were 27males (71.05%) and 11females (28.95%). In the Micro needling group, there were 23males (60.53%) and 15females (39.47%). Statistical analysis showed no significant difference in gender distribution between the groups.

TABLE 3: COMPARISON OF FIT PAT SKIN TYPE IN BOTH GROUPS

FIT PAT skin type	Total no. of patients	Erbium Yag		Micro needling	
		N	%	N	%
IV	42	20	52.63	22	57.89
V	34	18	47.37	16	42.11
Total	76	38	100.00	38	100.00

Chi square 0.212, P value 0.644 (NS)

Above table depicts, In the Erbium Yag group 20 (52.63%) cases were FIT PAT skin type IV and 18 (47.37%) cases were FIT PAT skin type V. In the Micro needling group 22 (57.89%) cases were FIT PAT skin type IV and 16 (42.11%) cases were FIT PAT skin type V. There was a statistically no significant difference in FIT PAT skin type distribution between the groups.

TABLE 4: COMPARISON OF PIH IN BOTH GROUPS

PIH	Total no. of patients	Erbium Yag		Micro needling	
		N	%	N	%
Present	35	15	39.47	20	52.63
Absent	41	23	60.53	18	47.37
Total	76	38	100.00	38	100.00

Chi square 1.324, P value 0.249 (NS)

In this study, 35 (46.05%) cases were present PIH out of 76 cases, in which 15 (39.47%) cases were Erbium Yag group and 20 (52.63%) cases were micro needling group. There was a statistically no significant difference in PIH distribution between the groups.

TABLE 5: COMPARISON OF SCAR TYPE IN BOTH GROUPS

Scar type	Total no. of patients	Erbium Yag		Micro needling	
		N	%	N	%
Box	14	9	23.68	5	13.16
Ice pick	64	33	86.84	31	81.58
Rolling	46	24	63.16	22	57.89

Chi square 0.748, P value 0.387 (NS)

Above table depicts, In the Erbium Yag group 9 (23.68%) cases were Box scar, followed by 33 (86.84%) cases were Ice pick scar and 24 (63.16%) cases were rolling scar. In the micro needling group 5 (13.16%) cases were Box scar, followed by 31 (81.58%) cases were Ice pick scar and 22 (57.89%) cases were rolling scar. There was a statistically no significant difference in scar type distribution between the groups.

TABLE 6: COMPARISON OF G & B GRADE AT BASELINE IN BOTH GROUPS

G & B Grade	Total no. of patients	Erbium Yag		Microneedling	
		N	%	N	%
I	11	7	18.42	4	10.53
II	26	12	31.58	14	36.84
III	32	17	44.74	15	39.47
IV	7	2	5.26	5	13.16
Total	76	38	100.00	38	100.00

Chi square 2.383, P value 0.496 (NS)

Above table depicts, In the Erbium Yag group at baseline 7 (18.42%) cases were G & B group I, followed by 12 (31.58%) cases were G & B grade II, 17 (44.74%) cases were G & B grade III and 2 (5.26%) cases were G & B grade IV. In the Micro needling group at baseline 4 (10.53%) cases were G & B group I, followed by 14 (36.84%) cases were G & B grade II, 15 (39.47%) cases were G & B grade III and 5 (13.16%) cases were G & B grade IV. There was a statistically no significant difference in G & B grade distribution between the groups.

TABLE 7: COMPARISON OF G & B GRADE AFTER 4TH SESSIONS IN BOTH GROUPS

G & B Grade	Total no. of patients	Erbium Yag		Microneedling	
		N	%	N	%
I	31	17	44.74	14	36.84
II	29	16	42.11	13	34.21
III	12	4	10.53	8	21.05
IV	4	1	2.63	3	7.89
Total	76	38	100.00	38	100.00

Chi square 2.934, P value 0.401 (NS)

Above table depicts, In the Erbium Yag group at after 4th session 17 (44.74%) cases were G & B group I, followed by 16 (42.11%) cases were G & B grade II, 4 (10.53%) cases were G & B grade III and 1 (2.63%) cases were G & B grade IV. In the Micro needling group at after 4th session 14 (36.84%) cases were G & B group I, followed by 13 (34.21%) cases were G & B grade II, 8 (21.05%) cases were G & B grade III and 3 (7.89%) cases were G & B grade IV. There was a statistically no significant difference in G & B grade distribution between the groups.

TABLE 8: ASSOCIATION OF G & B GRADE AT BASELINE TO AFTER 4TH SESSIONS IN ERBIUM YAG GROUP

G & B Grade	Erbium Yag			
	At Baseline		After 4th sessions	
	N	%	N	%
I	7	18.42	17	44.74
II	12	31.58	16	42.11
III	17	44.74	4	10.53
IV	2	5.26	1	2.63
Total	38	100.00	38	100.00

Chi square 13.11, P value 0.004 (S)

Above table depicts, in the Erbium Yag group at baseline there were 7 (18.42%) cases in G & B grade I and after 4th sessions were 17 (44.74%), 12 (31.58%) cases in G & B grade II and after 4th session were 16 (42.11%), 17 (44.74%) cases in G & B grade III and after 4th session were 4 (10.53%) and 2 (5.26%) cases in G & B grade IV and after 4th session were only 1 (2.63%).

TABLE 9: ASSOCIATION OF G & B GRADE AT BASELINE TO AFTER 4TH SESSIONS IN MICRO NEEDLING GROUP

G & B Grade	Microneedling			
	At Baseline		After 4th sessions	
	N	%	N	%
I	4	10.53	14	36.84
II	14	36.84	13	34.21
III	15	39.47	8	21.05
IV	5	13.16	3	7.89
Total	38	100.00	38	100.00

Chi square 8.223, P value 0.041 (S)

Above table depicts, in the micro needling group at baseline there were 4 (10.53%) cases in G & B grade I and after 4th sessions were 14 (36.84%), followed by 14 (36.84%) cases in G & B grade II and after 4th session were 13 (34.21%), 15 (39.47%) cases in G & B grade III and after 4th session were 8 (21.05%) and 5 (13.16%) cases in G & B grade IV and after 4th session were 3 (7.89%).

DISCUSSION

A prospective interventional study was conducted at department of orthopaedics, Pacific Institute of Medical Sciences, Sai Tirupati Hospital, Udaipur.In our study including 76participates presented with acne scar, 38 patients were divided into erbium YAG laser group and 38 patients into microneedling group.

AGE:

According to this study, majority of patients were found in the age group of 18-25 years 35 (46.05%), in which 20 (52.63%) cases in Erbium Yag group and (39.47%) cases in Micro needling group. The mean age was 25.94 years in Erbium Yag group and 26.57 years in Micro needling group. The mean age of total 76 participants was 26.26 years.

Osman MAR et al (2017)[1] showed that thirty patients with facial atrophic acne scars (10 men, 33.3%; 20 women, 66.7%) aged 21 to 41 (mean 276 3.75) years were randomized to study treatments. In another study done by **Emam AAM et al (2021)[2]** reported the aged range was 20 to 41 years with mean age being 27.29 years. **El-Taieb MA et al (2019)[3]** studied 75 patients with atrophic acne scars. Participant age ranged from 18 to 38 years with a mean of 26.7 ± 5.1 years, in which Erbium Yag group the mean age was 25.68years. In our study consist with Taieb MA et al.

GENDER:

In our study, of the 76 participants 50 (65.79%) were male and 26 (34.21%) were female. In the Erbium Yag group, there were 27males (71.05%) and 11females (28.95%). In the Micro needling group, there were 23males (60.53%) and 15females (39.47%).

Osman MAR et al (2017)[1] reported that 20 (66.7%) patients were female and 10 (33.3%) patients were male. **Emam AAM et al (2021)[2]** presented 9 males and 12 females. **Taieb MA et al (2019)[3]** determined that 27 patients were male (36%), and 48patients were female (64%).These studies show that women have more acne scars than men, but in our study there was a preponderance of men.

FIT PAT SKIN TYPE AND PIH

In this study, 42 (55.26%) participants had type IV FIT PAT skin and 34 (44.74%) had type V FIT PAT skin. Among them in Erbium Yag group 20 (52.63%) cases were FIT PAT skin type IV and 18 (47.37%) cases were FIT PAT skin type V and in Micro needling group 22 (57.89%) cases were FIT PAT skin type IV and 16 (42.11%) cases were FIT PAT skin type V.

35 (46.05%) cases were present PIH out of 76 cases, in which 15 (39.47%) cases were Erbium Yag group and 20 (52.63%) cases were micro needling group.

Osman MAR et al (2017)[1]revealed that most common Fitzpatric skin was type IV, which was 15 (50%) and second most common Fitzpatric skin was type III i.e. 14 (46.7%). Only one patient with Fitzpatrick skin Type V experiencedmild PIHon Er: YAG laser–treated side, which was resolved completely with the use of topical bleaching cream within 4 weeks.In similar study done by **El-Taieb MA et al (2019)**[3] seen that 16 (64%) patients had skin type IV and 9 (36%) patients had skin type III. Of a total 75 patients, 11 patients had PIH. This was in agreement with that observed by Hu and colleagues,[4] where also the incidence of PIH was less, seen only in 3% of the cases in 34 patients with Fitzpatrick skin Types III and IV using ablative fractional Er: YAG laser. Furthermore, a study on the use of fractional ablative Er: YAG laser with skin phototypes IV–V found PIH in only 2% after 100 settings (25 patients · 4 settings each).[5]

SCAR TYPE:

In present study, most common scar was ice pick, in which 64 (84.21%) and second most common scar was rolling 46 (60.53%). Of the 64 ice peak scar, 33(86.84%) were in the Erbium Yag group and 31 (81.58%) in the Micro needling group.

El-Taieb MA et al (2019) reported that most common scar was boxcar type 29 (38.67%) and second most common scar was icepick 26 (34.67%), among them 10 (40%) and 7 (28%) in Erbium Yag group respectively.

ASSOCIATION OF G & B GRADE AT BASELINE TO AFTER 4TH SESSIONS IN ERBIUM YAG GROUP AND MICRONEEDLING GROUP

According to this study, out of a total of 76 participants, 38 participants were given Erbium Yag treatment and after the fourth session from baseline, those in G & B grade III and IV improved to convert G & B grade I and II (86.85%). Rest 38 participants were given micro needling treatment and after the fourth session from baseline, G & B grade 3 and 4 patients improved to G & B grade 1 and 2 in 71.05% of participants but was lower than Erbium YAG.

FINAL OUTCOME (AFTER 4TH SESSION):

According to this study, in Erbium Yag group 17 (44.74%) participants had G & B grade I and 16 (42.11%) participants had G & B grade II at after 4th session. In micro needling group 14 (36.84%) participants had G & B grade I and 13 (34.21%) participants had G & B grade II at after 4th session.

Osman MAR et al (2017)[1] revealed that 10 (33.3%) patients satisfaction were excellent and 12 (40%) patients satisfaction had good in Erbium Yag group and 5 (16.7%) patients satisfaction had excellent and 7 (23.3%) patients satisfaction had good.

Patients treated with fractional Erbium Yag laser showed a marked improvement in the clinical appearance and grade of the acne scars,beside increase in epidermal and dermal thickness, indicating a highefficacy of fractional Erbium Yag laser. Many other studies reported that fractional Erbium Yag laser was found to be a highly effective and safe treatment modality of atrophic acne scars.[6-9]

SUMMARY AND CONCLUSION

A prospective interventional study was conducted at department of Dematology and Venerology, Pacific Institute of Medical Sciences, Sai Tirupati Hospital, Udaipur.In our study including 76participates presented with acne scar, 38 patients were divided into erbium YAG laser group and 38 patients into microneedling group.

SUMMARY:

1) Majority of patients were found in the age group of 18-25 years 35 (46.05%) and the mean age was 26.26 years. among them mean age was 25.94 years in Erbium Yag group and 26.57 years in Micro needling group.
2) Most of the male patients presented with acne scar 65.79%, among them 71.05% in Erbium Yag group and 60.53% microneedling group.Male preponderance was high as compare female.
3) Most common Fitzpatric skin was type IV, in which 55.26%, among them 52.63% in Erbium Yag group and 57.89% microneedling group.

4) 35 (46.05%) cases were present PIH out of 76 cases, in which 15 (39.47%) cases were Erbium Yag group and 20 (52.63%) cases were micro needling group.
5) Most common scar was ice pick, in which 64 (84.21%) and second most common scar was rolling 46 (60.53%).Of the 64 ice peak scar, 33(86.84%) were in the Erbium Yag group and 31 (81.58%) in the Micro needling group
6) Out of a total of 76 participants, 38 participants were given Erbium Yag treatment and after the fourth session from baseline, those in G & B grade III and IV improved to convert G & B grade I and II (86.85%). Rest 38 participants were given micro needling treatment and after the fourth session from baseline, G & B grade 3 and 4 patients improved to G & B grade 1 and 2 in 71.05% of participants but was lower than Erbium YAG.
7) In Erbium Yag group 17 (44.74%) participants had G & B grade I and 16 (42.11%) participants had G & B grade II at after 4th session. In micro needling group 14 (36.84%) participants had G & B grade I and 13 (34.21%) participants had G & B grade II at after 4th session.

CONCLUSION

In conclusions, Atrophic scars are more common in young men aged 20 to 30 years, and men had more atrophic scars than women in both groups.Our study also shows that both treatment Erbium Yag laser therapy and microneedling is effective and efficient in reducing scars, but The Erbium Yag laser was found to be superior to micro needling, and to have a reduction in pain levels and acne scars.

REFERENCES

1. Rook's textbook of dermatology, 9th edition. Edited by Griffiths. Barker, Bleiker, Chalmers, Creamer, Blackwell Publishing Ltd. Cole GT. 2010;9(90):90-1.
2. Kurokawa I, Danby FW, Ju Q, Wang X, Xiang LF, Xia L et al. New developments in our understanding of acne pathogenesis and treatment. Experimdermatol. 2009;18(10):821.
3. Chuah SY, Goh CL. The Impact of Post-Acne Scars on the Quality of Life Among Young Adults in Singapore. J Cutaneous Aesthetic Surg. 2015;8(3):153-8.
4. 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.
5. Kumari N, Kumar A, Bist JS, Mehta AK. Fractional erbium-YAG laser vs platelet rich plasma in acne scar: a comparative study. Int J Res Dermatol 2021;7:223-8.
6. Sardana K, Garg VK. Lasers in Dermatological Practice. 2014: JP Medical Ltd.
7. Goldenberg G, Patel S, Patel MJ, Williford P, Sangueza O. Eruptive squamous cell carcinomas, keratoacanthoma type, arising in a multicolor tattoo. J CutanPathol. 2008 Jan;35(1):62-4.
8. Al-Dhalimi M, Jaber A. Treatment of atrophic facial acne scars with fractional Er:Yag laser. J Cosmet Laser Ther. 2015;17(4):184-8.
9. Boas DA, Pitris C, Ramanujam N. Handbook of biomedical optics. 2016: CRC press.
10. Svelto O, Hanna DC. Principles of lasers. Vol. 1. 2010: Springer.
11. Koechner W. Solid-state laser engineering. Vol. 1. 2013: Springer.
12. Rao M. Applications of CO2 laser in Dermatology. Int. J. Adv. Pharmacy, Biol. Chem. 2013;2(3):501-6.
13. Goodman GJ. Management of post-acne scarring. What are the options for treatment? Am J Clin Dermatol. 2000 Jan-Feb;1(1):3-17.
14. Baldi A, PasqualiP, EP. Spugnini, Skin cancer: a practical approach. 2013: Springer Science & Business Media.
15. Emam AAM, Nada HA, Atwa MA, Tawfik NZ. Split-face comparative study of fractional Er:YAG laser versus microneedling radiofrequency in treatment of atrophic acne scars, using optical coherence tomography for assessment. J Cosmet Dermatol. 2022 Jan;21(1):227-236.
16. Jawade SA, Chugh V, Gohil S, Mistry A, Jawade SS, Ramapure R. Comparison of Sequential CO2 Laser and Dermaroller versus CO2 Laser Alone in the Treatment of Acne Scarring. J Datta Meghe Inst Med Sci Univ2021;16:739-42.

17. Tirmizi SS, Iqbal T, Mansoor M, Farooq N, Ather S, Fatima F, Kapadia N, Anwar A, Hashmi AA. Role of Microneedling in Atrophic Post-Acne Scars: An Experience from a Tertiary Care Hospital. Cureus. 2021 Jan 8;13(1):e12578.
18. Tejaswini KS, Lakshmi NB, Ramachandra BV. Management of Acne Scars: Comparative Study of Therapeutic Efficacy of Fractional CO2 Laser and Micro - Needling with and Without Topical Epidermal Growth Factor Application Post – Procedure. International Journal of Science and Research. 2021;10(12):720-4.