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A comparative study of efficacy of microneedling with Dermapen versus Fractional CO2 laser in treatment of atrophic acne scars

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Abstract:

Acne is a chronic inflammatory disease of pilosebaceous glands that affects approximately 85% of adolescents and young adults. Acne commonly presents on area which are rich in pilosebaceous glands like face, upper arm, trunk and back. Acne scars occur as a result of inflammatory process associated with acne vulgaris which leads to abnormal production and degradation of collagen during healing process. Acne scarring is a significant concern for many patients, as it can lead to psychological distress, reduced self-esteem and have negative impact on quality of life. This randomized comparative study evaluates the efficacy and safety of Fractional carbon dioxide (CO2), laser versus microneedling with Dermapen therapy in management of atrophic acne scars. Fifty-four patients with clinical diagnosis of atrophic acne scars were assigned to two treatment groups: Group A received treatment with Fractional carbon dioxide laser therapy, while Group B underwent treatment with microneedling with Dermapen. Each patient received three treatment sessions at four-week intervals with follow up till 12th week. The results demonstrate that both modalities reduce the severity of acne scars, however microneedling (Dermapen) demonstrated earlier and superior qualitative/patient-reported improvement compared to Fractional CO2 laser, with fewer side effects. Both treatments were effective over time, but microneedling may offer better tolerability and faster initial results.

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Introduction

Acne is a chronic inflammatory disease of pilosebaceous glandsthat is characterized by comedones, papules, pustules and sometime nodules. Althoughoften associated with adolescence, it can persist into adulthood causing post inflammatory hyperpigmentation (PIH) and scars. Individuals with darker skin are prone to PIH. Pilosebaceous units become clogged with excess sebum and dead cells that make environment conducive to growth of Cutibacteriumacne[1,2]. The immune system responds by releasing inflammatory mediators, which damage the surrounding tissue. About 95% of individuals with acne develop scarring, the severity of which varies widely[3].

Severity of scarring depends on many factors including depth and duration of inflammation, genetic predisposition, skin type, acne severity and manipulation of lesions. Acne scars are broadly classified into atrophic, hypertrophic and keloid. Atrophic scars are more common and result from loss of collagen during healing process of inflammatory acne. The structural damage leads to a depression or indentation in skin. Atrophic scars are further categorized into three subtypes depending on their

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shape, depth and extent of skin involvement[4,5,6]. Icepick scars are narrow and deep scars with sharply demarcated edges that resemble small punctures or holes. Boxcar scars are broader, round or oval depressions with well-defined vertical edges. They may be shallow or narrow. Rolling scars present as undulating depressions in the skin, caused by tethering of dermis to underlying structure through fibrous bands. These are typically wide and have sloping appearance, giving the skin a wavy texture. Hypertrophic scars are raised scars that remain within the boundaries of original lesion, whereas keloidare raised scars that extend beyond the original lesion and more common in individual with dark tone.

Preventing acne scars is crucial and begins with early treatment of acne to minimize extent of dermal damage. Acne scar treatment depends on the type, severity and skin type of patient. Treatment options include Chemical peels, Microneedling, Laser resurfacing, Subcision, Dermal fillers, Punch techniques and Platelet rich plasma. Microneedling is a minimally invasive treatment with short downtime. It involves use of fine needles to create controlled microinjuries to skin, stimulating collagen and elastin production. Fractional carbon dioxide laser works by delivering short pulses of high-energy light to the skin, vaporizing the outer layers and stimulating collagen production in the deeper layers[7].

The present study was conducted to compare the efficacy of Fractional CO2 laser versus microneedling with dermapen in treatment of atrophic acne scar in a tertiary care center in Northern India.

Material and method

This study was a randomised controlled study that aimed to evaluate the comparative efficacy and safety of Fractional carbon dioxide (CO2) laser versus microneedling with Dermapen in the treatment of acne scars. The study was conducted at a teaching hospital over a period of 24 months, following approval from the institutional ethics committee.

A total of 54 patients with clinical diagnosis of acne scars were enrolled in the study after written informed consent. Patients having keloidal tendencies, collagen vascular diseases, bleeding disorders, patients on chronic corticosteroid or anticoagulant therapy, pregnant or lactating women, patient on medications known to cause hyperpigmentation, such as Amiodarone, Clofazimine, or Minocycline, individuals with active facial infections and patients with facial scars due to other causes were excluded from the study.

An initial assessment was done by thorough history-taking and clinical examination of acne scars was performed to evaluate the severity and type of scars. Photographic documentation of the facial scars was done for baseline reference. The severity of acne scars was evaluated using Goodman and Baron's qualitative and quantitative grading systems. Participants were randomly divided into two groups using a simple randomization technique with each group consisting of 27 individuals. Group A received treatment with Fractional CO2 laser with fluence (energy)10-15 J/cm² and spot size 2-4 mm. Group B received treatment with microneedling using a Dermapen device equipped with 12 needles. The needle depth was set to 3 mm and microneedling was performed in four directions to ensure uniform treatment and to achieve pinpoint bleeding as an endpoint. Both groups underwent three treatment sessions spaced at four-week intervals. After each session, participants were provided with topical antibiotic coverage to prevent infections and support wound healing. Scars were re-evaluated using Goodman and Baron's grading systems after each treatment session and photographs were taken after every session to visually compare the pre-treatment and post-treatment improvements. The final evaluation was based on changes in Goodman and Baron's (GB) qualitative and quantitative grading scores, visual comparison of photographic records and patient-reported satisfaction and progress.

Statistics

The statistical analysis was performed using SPSS software version 22.0. Descriptive statistics were used to summarize patient demographics, personal history, duration of scars, facial distribution of scars, and treatment outcomes. Treatment outcomes with Goodman and Baron's Qualitative and Quantitative score as well as Visual Analogue Scale, were presented as mean ± standard deviation (SD) and compared using the independent t-test as appropriate. Acne scar type according to facial distribution, and side effects, were expressed as percentages and compared using the Student's t-test test. A p-value of less than 0.05 was considered statistically significant.

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To assess improvement in acne scars over time, Goodman and Baron's Qualitative and Quantitative score, along with the Visual Analogue Scale was used.

Results

A total of 54 patients were included in study and divided into 2 groups with 27 patients each. Group A underwent treatment with Fractional CO2 laser and Group B underwent treatment with Dermapen. In group A, mean age was 26.78 ± 4.52 years and in group B mean age was 27.52 ± 6.17 years, statistically the difference was not significant (p=0.413). In Group A, maximum (59.3%) patients were females, while in Group B, maximum patients were males (51.9%). The mean duration of symptoms was 3.63±2.01 years in Group A and 4.26±3.14 years in Group B, statistically this difference was not significant. (p=0.384)

According to facial distribution, on malar region, majorly icepick scars were present with mean of 7.26 and 7.31 on right and left side respectively in group A and mean of 6.42 and7.53 was present on right and left side respectively in group B. On chin, maximum boxcar scar were present with mean of 4.00 and 2.00 in group A, and in group B respectively. On nose, in group A, maximum boxcar scar was present with mean of 3.25 and in group B, majorly icepick scars was present with mean of 3.00. On forehead, maximum number of icepick scars was present with mean 2.85 in group A and in group B most common scar was rolling with mean of 2.50.

GB quantitative scores within groups revealed a significant improvement at all intervals (4th week to 12th week) from baseline with both the groups showing decrease in severity of acne scars (Table1). On comparison between groups, GB quantitative scores were comparable in Group A and Group B at Baseline (2.59±0.69 vs. 2.33±0.62) p=0.154. On comparison, at 4th (2.00±0.83 vs. 1.52±0.64) p=0.021 and 8th week (1.48±0.70 vs. 1.04±0.44) p=0.007 both groups showed decrease in GB quantitative score with group B showing significant results. However, at 12th week, both groups showed improvement, but differences remained statistically insignificant (0.75±0.44 vs. 0.46±0.51) p=0.052(Table 2).

Both groups showed decrement in GB qualitative scores. However, no significant difference was found between the two groups at any observation interval. (Table 3)

On intergroup comparison of Visual analogue scale (VAS), significant difference was found at 4th and 12th weeks with group B showed better results. At 4thweek, 77.8% patient in Group A had VAS 2score however in Group B, 74% patient had VAS 2 and VAS 3 score (p=0.014) (Table4). At 8th week, 92.5% patient in Group A had VAS 2 and VAS 3 score and in Group B 96.3% patient had VAS 2 and VAS 3 score (p=0.250) (Table 4). At 12th week, maximum (92.6%) patient had VAS 2 and VAS 3 score however in group B, 66.6% patient had VAS 4 and VAS 5 score (p=0.038) (Table4). The higher proportion of patients in Group B attaining more substantial improvement suggests a relatively superior treatment response in this group.

In terms of complications, only PIH was reported in three patients (11.1%) in Group A and one case in Group B, but the difference remains statistically insignificant (3.7%) (p=0.299).

Table 1: Intragroup comparison of GB quantitative Score from baseline

SN		Group A (CO2 laser)					Group B (Dermapen)				
		Mean difference	SD	% change	't'	'p'	Mean difference	SD	% change	't'	'p'
1	Week 4	0.59	0.64	22.78	4.841	<0.001	0.82	0.64	34.98	6.213	<0.001
2	Week 8	1.11	0.51	42.8571	11.402	<0.001	1.30	0.47	55.62	14.475	<0.001
3	Week 12	1.85	0.65	71.4286	11.103	<0.001	1.90	0.65	82.27	14.360	<0.001

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Table 2: Intergroup comparison of Goodman and Baron's (GB) Quantitative score at different intervals

SN		Group A (CO2 laser)		Group B (Dermapen)		Student's t-test	
		Mean	SD	Mean	SD	't'	'p'
1	Baseline	2.59	0.69	2.33	0.62	1.448	0.154
2	Week 4	2.00	0.83	1.52	0.64	2.380	0.021
3	Week 8	1.48	0.70	1.04	0.44	2.799	0.007
4	Week 12	0.75	0.44	0.46	0.51	2.004	0.052

Table 3: Intergroup comparison of GB Qualitative scores at different observations

SN	Interval		Group A (CO2 laser)		Group B (Dermapen)		Chi-sq. test	
			No.	%	No.	%	χ^2	'p'
1	Baseline	Macular	0	0	0	0	0.336	0.845
		Mild	3	11.1	3	11.1		
		Moderate	12	44.4	14	51.9		
		Severe	12	44.4	10	37.0		
2	4th Week	Macular	0	0.00	2	7.40	4.116	0.249
		Mild	6	22.20	8	29.60		
		Moderate	17	63.00	16	59.30		
		Severe	4	14.80	1	3.70		
3	8th Week	Macular	1	3.70	5	18.50	3.692	0.158
		Mild	20	74.10	19	70.40		
		Moderate	6	22.20	3	11.10		
		Severe	0	0	0	0		
4	12th Week	Macular	16	59.30	21	77.80	2.146	0.143
		Mild	11	40.70	6	22.20		
		Moderate	0	0	0	0		
		Severe	0	0	0	0		

Table 4: Intergroup comparison of Improvement using VAS

At 4th week					
SN	VAS (% improvement)	Group A (CO2 laser)		Group B (Dermapen)	
		No	%	No	%
1	0 (<10%)	0	0.0	1	3.7
2	1 (10-24%)	6	22.2	5	18.5
3	2 (25- 49%)	21	77.8	12	44.4
4	3 (50-74%)	0	0.0	8	29.6
5	4 (75-89%)	0	0.0	1	3.7
χ^2= 12.545; p=0.014					
At 8th week					
1	0 (<10%)	0	0.0	0	0.0
2	1 (10-24%)	2	7.4	1	3.7
3	2 (25- 49%)	12	44.4	7	25.9
4	3 (50-74%)	13	48.1	19	70.4

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5	4 (75-89%)	0	0.0	0	0.0
χ^2= 2.774; p=0.250					
At 12thweeek					
1	0 (<10%)	0	0.0	0	0.0
2	1 (10-24%)	1	3.7	1	3.7
3	2 (25-49%)	9	33.3	8	29.6
4	3 (50-74%)	16	59.3	9	33.3
5	4 (75-89%)	1	3.7	9	33.3
χ^2= 8.419; p=0.038					

Discussion

The management of atrophic acne scars remains a significant challenge in dermatology, with Fractional CO_2 laser and microneedling emerging as two of the most widely used treatment modalities. Microneedling involves use of fine needles to create controlled microinjuries to skin, stimulating collagen and elastin production. Fractional CO2 laser works by delivering short pulses of high-energy light to the skin, vaporizing the outer layers and stimulating collagen production in the deeper layers[8].

By examining the present study in the context of contemporary literature, we can identify areas of consensus, divergence, and potential avenues for future research.

In present study, mean age of patients in Group A was 26.78 ± 4.52 years and in Group B, 27.52 ± 6.17 years. Our cohort consisted predominantly of young adults, which aligns with the age ranges reported in multiple studies. Agarwal *et al.*[9], in their study included 30 patients, aged between 20 & 40 years. In another study by Brar *et al.*[10] included 50 patients and most common age group among the patients was 21-30 years. Most of the other studies, included a similar aged patient (16-45 years) [9,10]. This consistency across studies reflects the typical patient population seeking treatment for post-acne scarring.

Females predominated in Group A (59.3%) and males in Group B (51.9%), however the differences in gender distribution between the groups were not statistically significant. The slight female predominance in our CO_2 laser group echoes findings from Hendel *et*[8] who reported a higher prevalence of females in their study, while contrary to the present study, Brar *et al*[10]reported male preponderance in their study.

The present study found that while both Fractional CO2 laser and microneedling led to significant improvements in acne scars, microneedling demonstrated superior qualitative results at earlier follow-up intervals (4th week and 8th week) as measured by the Goodman and Baron (GB) quantitative score, as evident by decreasing score with the progression of follow-up. By week 12, the difference was no longer statistically significant, indicating both treatments yield comparable long-term outcomes. Contemporary studies present a more heterogeneous picture. Some research, such as that by Pooja *et al.*[11] reported 68.7%±10.5 improvement in GB quantitative scores after 4th session in patients treated with CO_2 laser, while during the same time patients treated with Microneedling had 60.3%±14.5 improvement, while in another study, Agarwal *et al.*[9], reported in their study that there was 32.9%improvement in GB grade in CO2 laser, while improvement on the with microneedling was 9.3%. These findings support the superiority of fractional CO_2 laser in terms of qualitative scar remodelling, particularly for rolling and boxcar scars. The discrepancy in findings may stem from differences in study design, including variations in treatment protocols;e.g., laser energy settings, microneedling depth, number of sessions; and patient demographics (e.g., scar type, skin phototype).One of the most

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consistent findings across both the present study and contemporary research is the favourable safety profile of microneedling compared to Fractional CO_2 laser.

By comparing GB qualitative score, at baseline, the distribution of scar severity was similar between Group A and Group B, with no statistically significant difference (p=0.845). At 4 weeks, both groups showed improvement, but differences remained statistically insignificant (p=0.249). By 8 weeks, no severe scarring was observed in either group, and the shift toward milder and macular scarring was more evident, though still not significant (p = 0.158). At 12 weeks, all patients had either mild or macular scarring, with no significant difference between groups (p = 0.143), indicating comparable progression of scar improvement over time. Our study assessed scar severity using the Goodman-Baron scale without differentiating scar subtypes, unlike studies that analyzed specific scar types. Agarwal et al[9] found CO_2 laser more effective for rolling/boxcar scars but not icepick scars, suggesting our generalized approach may overlook subtype-specific responses. Similarly, Badheka et al[12] showed that combining subcision with microneedling was most effective for tethered scars, a method not used in our study. These findings highlight a key limitation and suggest that future research should incorporate scar subtyping to optimize treatment strategies.

The present study found that patients underwent microneedling reported significantly higher satisfaction at multiple follow-up intervals as measured by VAS scores. At 4th Week, in Group A, none of the patients experienced a 50% or greater improvement. Conversely, in Group B 77.7% patients exhibiting over 50% improvement. At 8th week, almost half (48.1%) of the patients showed improvement between 50% and 74% in group A. In contrast, Group B had a larger percentage of patients (70.4%) with 50-74% improvement. Lastly at 12th week, majority in Group A (59.3%) had a 50-74% improvement (VAS 3). In Group B, most patients (66.6%) improved by 50-89%. This aligns with studies such as Sharada *et al.*[13], where microneedling RF was associated with better patient-reported outcomes due to its minimal side effects and gradual, natural-looking improvement. The present study adds to a growing body of evidence that microneedling is a safe, effective, and patient-friendly option for atrophic acne scars, particularly in the early post-treatment phase. Its lower risk of PIH and faster recovery make it especially suitable for patients with darker skin tones or those seeking minimal downtime. Whereas Fractional CO_2 laser may be preferable, such as in cases of severe scarring or when deeper collagen remodelling is desired. Personalized treatment selection based on scar type, skin phototype, and patient preferences will be crucial. In the present study, post-inflammatory hyperpigmentation occurred in 11.1% of patients treated with CO_2 laser, compared to only 3.7% in the microneedling group (p= 0.299). This finding is corroborated by multiple studies, including Agarwal *et al.*[9], which reported a 30% incidence of PIH with CO_2 laser versus 6.67% with microneedling, particularly in patients with darker skin.

Conclusion

The findings of the present study suggest that Microneedling (Dermapen) demonstrated earlier and superior qualitative/patient-reported improvement compared to fractional CO_2 laser, with fewer side effects. Both treatments were effective over time, but microneedling may offer better tolerability and faster initial results.

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