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Comparative Efficacy of 50% Trichloroacetic Acid and Fractional CO_2 Laser in the Treatment of Xanthelasma Palpebrarum: A Prospective Study

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ABSTRACT

Introduction: Xanthelasma palpebrarum is a common benign periocular xanthoma characterized by yellowish plaques over the eyelids, frequently associated with dyslipidemia and cardiovascular risk factors. Although asymptomatic, its cosmetic disfigurement often necessitates treatment. Among the various therapeutic modalities available, trichloroacetic acid (TCA) and fractional CO_2 laser are widely used, each with distinct advantages and limitation. To compare the efficacy and clinical outcomes of 50% trichloroacetic acid and fractional CO_2 laser in the management of xanthelasma palpebrarum.

Methods: A prospective comparative study included fifty six patients with clinically diagnosed xanthelasma palpebrarum. Participants were divided into two equal groups. Group A received 50% TCA application, while Group B received fractional CO_2 laser. Outcomes were assessed in terms of percentage lesion clearance, rate of response, and overall cosmetic results.

Results: Both treatment modalities resulted in significant improvement in lesion clearance. However, fractional CO_2 laser demonstrated a significantly faster rate of clearance, higher final percentage improvement, and superior cosmetic outcomes compared to TCA. In contrast, 50% TCA, while slower in action, proved to be an effective and economical option, particularly for smaller and superficial lesions. Adverse effects in both groups were minimal and transient.

Conclusion: Both 50% trichloroacetic acid and fractional CO_2 laser are effective treatment options for xanthelasma palpebrarum. Fractional CO_2 laser offers superior efficacy and aesthetic outcomes, whereas 50% TCA remains a cost-effective alternative, especially in resource-limited settings.

Keywords: *Xanthelasma palpebrarum, Trichloroacetic acid, Fractional CO_2 laser, Chemical cauterization, Laser therapy.*

INTRODUCTION

Xanthelasma palpebrarum (XP) is the most common form of cutaneous xanthoma and is characterized clinically by soft, yellowish to yellow-orange, well-demarcated plaques that typically occur on the medial aspect of the upper and lower eyelids. Histopathologically, these lesions are composed predominantly of lipid-laden macrophages or foam cells situated within the superficial dermis. XP most commonly affects middle-aged and older adults and has been reported to show a slight female predominance.[1] Although the condition is benign and usually asymptomatic, its conspicuous periocular location frequently causes cosmetic concern and may adversely affect an individual's self-image and psychosocial well-being.

The clinical significance of XP extends beyond its cosmetic appearance. Disorders of lipid metabolism have frequently been reported in affected individuals, with approximately half of patients demonstrating some degree of dyslipidemia.[2] In addition, XP may occur in apparently normolipidemic individuals, suggesting that abnormalities in lipid handling, local cholesterol deposition, or other metabolic and vascular mechanisms may contribute to its development. Previous studies have also suggested an association between XP and cardiovascular risk factors, emphasizing the importance of appropriate clinical evaluation and lipid profiling in affected patients.[2,3] Thus, XP may serve not only as a dermatological condition requiring cosmetic treatment but also as a potential clinical indicator warranting assessment for underlying metabolic abnormalities.

Management of XP remains challenging because of its periocular location, variable lesion size and depth, cosmetic expectations of patients, and tendency for recurrence. A wide range of therapeutic modalities has been described, including chemical cauterization with trichloroacetic acid (TCA) or bichloroacetic acid, surgical excision, cryotherapy, electrocautery, radiofrequency-based procedures, and various laser systems.[4] Selection of an appropriate treatment modality depends on several factors, including lesion size, thickness and location, skin type, availability of equipment, operator expertise, treatment cost, anticipated downtime, and the patient's preference. An ideal treatment should provide satisfactory lesion clearance while minimizing postoperative erythema, pigmentary alteration, scarring, and recurrence.

Trichloroacetic acid is one of the most commonly used chemical agents for the treatment of superficial xanthelasma because it is inexpensive, readily available, and relatively simple to administer in an outpatient setting. It produces controlled chemical cauterization through protein coagulation, resulting in focal tissue necrosis followed by re-epithelialization and remodeling.[5] The depth of tissue injury is influenced by the concentration of TCA, the amount applied, and the number of applications. Although higher concentrations may produce greater lesion clearance, they may also increase the risk of complications such as post-inflammatory hyperpigmentation, hypopigmentation, prolonged erythema, and scarring, particularly on the thin and sensitive eyelid skin. Consequently, intermediate concentrations such as 50% TCA may offer a practical balance between efficacy and tolerability.

Laser-based treatment has increasingly become an important therapeutic option for XP because it allows more controlled and precise destruction of lesional tissue. The carbon dioxide (CO_2) laser emits light at a wavelength of 10,600 nm, which is strongly absorbed by water-containing tissues and produces rapid vaporization with simultaneous coagulation of small vessels. Fractional CO_2 laser technology delivers energy through multiple microscopic treatment columns while leaving intervening areas of relatively intact skin, thereby facilitating re-epithelialization and potentially reducing recovery time.[6] Its precision is particularly advantageous in the periocular region, where excessive tissue injury may lead to cosmetically undesirable scarring or pigmentary changes. Fractional CO_2 laser may therefore provide rapid and substantial lesion clearance while permitting controlled treatment of lesions of varying size and thickness.

Despite these therapeutic options, treatment of XP continues to present important clinical challenges. Recurrence following apparently successful treatment remains a concern, and post-treatment erythema, pigmentary alterations, and scarring may affect patient satisfaction. Moreover, no single therapeutic modality has been universally accepted as the gold standard. Differences in lesion characteristics, treatment concentrations, laser parameters, number of treatment sessions, follow-up duration, and definitions of clinical response make direct comparison between available studies difficult.[7] These variations highlight the need for prospective comparative studies using clearly defined treatment protocols and standardized outcome assessment.

Direct comparison of 50% TCA with fractional CO_2 laser is particularly relevant in clinical practice because the two modalities differ substantially in cost, availability, technical requirements, and mechanism of action. TCA offers the advantages of simplicity and affordability and can be readily employed in settings where sophisticated laser equipment is unavailable. Fractional CO_2 laser, in contrast, requires specialized equipment and expertise but may provide more precise tissue ablation and faster clinical improvement. Establishing their relative efficacy under comparable clinical conditions can therefore help clinicians select an appropriate modality according to lesion characteristics, available resources, and patient expectations, particularly in resource-conscious healthcare settings.

Therefore, the present study was undertaken to compare the efficacy of 50% trichloroacetic acid and fractional CO_2 laser in the treatment of xanthelasma palpebrarum.

MATERIAL AND METHODS

Study Design and Setting

This prospective, interventional, comparative study was conducted over a period of 18 months in the Department of Dermatology, Venereology and Leprosy, Prasad Institute of Medical Sciences, Lucknow, Uttar Pradesh, India. The study was initiated after obtaining approval from the Institutional Ethics Committee/Review Board. Written informed consent was obtained from all participants before enrollment and initiation of any study-related procedure.

Study Population and Group Allocation
A total of 56 patients with clinically diagnosed xanthelasma palpebrarum were enrolled in the study. Eligible participants were randomly allocated in a 1:1 ratio into two treatment groups using the sealed-envelope method. Group A comprised 28 patients who received treatment with 50% trichloroacetic acid (TCA), whereas Group B comprised 28 patients who underwent treatment with fractional carbon dioxide (CO_2) laser.

Inclusion Criteria
Patients were eligible for inclusion if they were aged 18–60 years, had a clinical diagnosis of xanthelasma palpebrarum, had not received any treatment for the lesions during the preceding one year, were willing to undergo the assigned treatment and regular follow-up, and provided written informed consent for participation.

Exclusion Criteria
Pregnant or lactating women were excluded from the study. Other exclusion criteria included active infection at the treatment site, a history of hypertrophic scar or keloid formation, and use of systemic retinoids within the preceding 6 months.

Baseline Clinical Assessment
At enrollment, a detailed clinical history was obtained and a thorough dermatological examination was performed. The characteristics of the xanthelasma lesions were documented, and standardized baseline clinical photographs were obtained before treatment. A lipid profile was also performed for all participants before initiation of therapy.

Treatment Protocol
Group A: 50% Trichloroacetic Acid
In Group A, the treatment area was thoroughly cleansed and degreased with acetone before application. A 50% TCA solution was carefully applied over the xanthelasma lesion using a pointed wooden applicator. The solution was applied in 2–3 controlled coats until uniform white frosting of the treated area was observed. Care was taken to restrict the application to the lesion and minimize contact with the surrounding normal skin.

Treatment sessions were performed at 3-week intervals for a maximum of four sittings or until complete lesion clearance, whichever occurred earlier.

Group B: Fractional CO_2 Laser

The patient's affected area of skin was cleansed and degreased with acetone initially. The xanthelasma palpebrarum to be treated was identified and marked with markers.Thick application of topical anaesthesia was done and left for 45 minutes before the procedure. Adequate ocular protection was ensured by instillation of topical anesthetic eye drops (e.g., 0.5% proparacaine or 0.5% tetracaine), followed by lubrication of the ocular surface and insertion of sterile metallic intraocular corneal shields prior to fractional CO_2 laser procedure.
Treatment parameters was set using an average power of 20 W, pulse duration of 0.1 ms, distance of 500 μm. The handpiece will be steadily moved over the target area, applying even pressure and leaving a uniform mesh to remove the stratum corneum without affecting the lower skin layers. 1-2 passes given during each session with fine adjustment depending on skin type and patient's reactions.
Following the procedure, the site was gently wiped with cold water and an ice pack will be applied for 5 minutes to relieve discomfort and minimize swelling.
Patient was kept under observation for 30 minutes post-procedure to observe for any immediate adverse effects such as erythema, edema, burning sensation,or any other reactions.

Follow-up and Outcome Assessment
Patients were evaluated at each treatment visit to assess the clinical response. The primary assessment was based on percentage lesion clearance following successive treatment sittings. The rate of improvement and final percentage clearance after completion of treatment were recorded for both groups.
The final treatment response was categorized using a clinical outcome score ranging from 0 to 4. Treatment outcomes were compared between the two groups after completion of the scheduled treatment sessions. Patients were also clinically evaluated for treatment-related adverse effects during follow-up.

Statistical Analysis
Statistical analysis was performed using Epi Info software. Quantitative variables were summarized as mean ± standard deviation (SD), while categorical variables were expressed as frequencies and percentages. The Chi-square test was used to compare categorical variables between the groups. The independent-samples t-test was used for comparison of quantitative variables between Group A and Group B, whereas the paired t-test was used for within-group comparisons, where applicable. All statistical tests were two-tailed, and a p-value <0.05 was considered statistically significant.

Figure 1: At Baseline Group A and Group B Respectively

Figure 2: After 4 Sessions Group A and Group B Respectively

RESULTS

A total of 56 patients with xanthelasma palpebrarum were included in the study and allocated equally into two treatment groups. Group A comprised 28 patients treated with 50% trichloroacetic acid (TCA), while Group B comprised 28 patients treated with fractional CO_2 laser. The demographic characteristics, baseline lesion area, sequential lesion clearance, and final treatment outcomes were compared between the two groups.

Demographic and Baseline Characteristics

Table 1. Demographic and Baseline Characteristics of the Study Participants (N = 56)

Parameter	Group A — 50% TCA (n = 28)	Group B — Fractional CO_2 Laser (n = 28)	p-value
Mean age (years)	34.6 ± 14.2	32.9 ± 10.1	0.58

Male, n (%)	12 (42.9%)	11 (39.3%)	0.79
Female, n (%)	16 (57.1%)	17 (60.7%)	0.79
Mean baseline lesion area (mm^2)	6.29 ± 2.1	7.96 ± 2.8	**0.013***

*Values are expressed as mean ± SD or n (%), as appropriate. *p < 0.05 was considered statistically significant.*

The mean age of participants was 34.6 ± 14.2 years in Group A and 32.9 ± 10.1 years in Group B, with no statistically significant difference between the groups ($p = 0.58$). Females constituted 57.1% of Group A and 60.7% of Group B, while males accounted for 42.9% and 39.3%, respectively. Sex distribution was also comparable between the two groups ($p = 0.79$). However, the mean baseline lesion area was significantly greater in Group B (7.96 ± 2.8 mm^2) than in Group A (6.29 ± 2.1 mm^2; $p = 0.013$), indicating that patients in the fractional CO_2 laser group had larger lesions at baseline.

Table 2. Comparison of Mean Percentage Lesion Clearance at Successive Treatment Sittings

Treatment Sitting	Group A — 50% TCA, Mean Clearance (%)	Group B — Fractional CO_2 Laser, Mean Clearance (%)	Mean Difference (%)	p-value
1st sitting	15.30	45.30	30.00	**<0.001**
2nd sitting	30.90	68.00	37.10	**<0.001**
3rd sitting	47.00	78.10	31.10	**<0.001**
4th sitting	58.30	84.10	25.80	**<0.001**

Values represent mean percentage lesion clearance. p < 0.05 was considered statistically significant.

A progressive increase in lesion clearance was observed with successive treatment sittings in both groups. However, the fractional CO_2 laser group demonstrated significantly greater clearance at every assessment. Following the **first sitting**, mean lesion clearance was 45.30% in Group B compared with 15.30% in Group A, corresponding to a difference of 30.00 percentage points ($p < 0.001$). After the second sitting, clearance increased to 68.00% and 30.90%, respectively, with the largest observed between-group difference of 37.10 percentage points ($p < 0.001$). At the third sitting, Group B continued to demonstrate greater clearance than Group A (78.10% vs. 47.00%; $p < 0.001$). By the fourth sitting, mean clearance reached 84.10% in the fractional CO_2 laser group compared with 58.30% in the TCA group ($p < 0.001$). Thus, fractional CO_2 laser produced consistently greater lesion clearance throughout the treatment period.

Table 3. Comparison of Final Percentage Lesion Clearance After Completion of Treatment

Parameter	Group A — 50% TCA (n = 28)	Group B — Fractional CO_2 Laser (n = 28)	p-value
Mean final clearance (%)	58.25 ± 6.4	84.1 ± 8.9	**<0.001**
Median clearance (%)	59	86	—
Range (%)	44–67	64–100	—
Patients achieving ≥80% clearance	0 (0%)	>50%	**<0.001**

Values are expressed as mean ± SD, median, range, or proportion, as applicable.

The final treatment response demonstrated a marked difference between the two modalities. Mean final lesion clearance was 58.25 ± 6.4% in Group A compared with 84.1 ± 8.9% in Group B, and this difference was statistically significant ($p < 0.001$). The median final clearance was also substantially higher with fractional CO_2 laser (86%) than with 50% TCA (59%). Final clearance ranged from 44% to 67% in Group A and from 64% to 100% in Group B. None of the patients treated with 50% TCA achieved ≥80% clearance, whereas more than half of the patients treated with fractional CO_2 laser achieved this level of clearance ($p < 0.001$). These findings demonstrate a substantially greater final lesion response with fractional CO_2 laser.

Table 4. Distribution of Final Clinical Outcome Scores in the Two Treatment Groups

Score	Interpretation	Group A — 50% TCA, n (%)	Group B — Fractional CO_2 Laser, n (%)
2	Fair response	2 (7.1%)	0 (0%)
3	Good response	26 (92.9%)	7 (25.0%)
4	Excellent response	0 (0%)	**21 (75.0%)**
Total		**28 (100%)**	**28 (100%)**

The distribution of final clinical outcome scores further demonstrated the difference in treatment response. In Group A, 26 of 28 patients (92.9%) achieved a good response (Score 3), while 2 patients (7.1%) had a fair response (Score 2). None of the patients treated with 50% TCA achieved an excellent response. In contrast, 21 of 28 patients (75.0%) in Group B achieved an excellent response (Score 4), while the remaining 7 patients (25.0%) achieved a good response (Score 3). No patient in the fractional CO_2 laser group had a fair response. Thus, excellent clinical outcomes were observed predominantly among patients treated with fractional CO_2 laser.

Table 5. Summary Comparison of Key Demographic and Treatment Outcomes

Outcome Measure	Group A — 50% TCA	Group B — Fractional CO_2 Laser	Comparative Finding
Mean age (years)	34.6	32.9	No significant difference
Sex distribution	43% M / 57% F	39% M / 61% F	No significant difference
Baseline lesion area	6.29 mm^2	7.96 mm^2	Significantly larger in Group B
Clearance after 1st sitting	15.30%	45.30%	**Higher in Group B***
Clearance after 4th sitting	58.30%	84.10%	**Higher in Group B***
Mean final clearance	58.25%	84.10%	**Higher in Group B***
Excellent outcome (Score 4)	0%	75.0%	**Higher in Group B**

**p < 0.001 for the reported lesion-clearance comparisons.*

Overall, the demographic characteristics of the two treatment groups were comparable with respect to age and sex. Although Group B had a significantly larger mean lesion area at baseline, patients treated with fractional CO_2 laser demonstrated greater lesion clearance from the first treatment sitting onward. By the fourth sitting, mean clearance reached 84.10% with fractional CO_2 laser compared with 58.30% with 50% TCA. Similarly, mean final clearance was substantially greater in Group B (84.10% vs. 58.25%), and 75.0% of patients in the laser group achieved an excellent outcome, whereas no excellent responses were recorded in the TCA group.

Taken together, these findings demonstrate that although both treatment modalities resulted in progressive improvement in xanthelasma palpebrarum, fractional CO_2 laser was associated with significantly faster lesion clearance and a greater final treatment response than 50% TCA, despite the larger baseline lesion area in the fractional CO_2 laser group.

DISSCUSSION

Xanthelasma palpebrarum (XP) is a benign but cosmetically significant periocular disorder characterized by lipid-laden foam cell deposits in the superficial dermis. Despite the availability of numerous treatment modalities — including chemical peeling, laser ablation, radiofrequency, cryotherapy, and surgical excision — no universally accepted gold standard exists. The present prospective comparative study was therefore undertaken to evaluate the efficacy of 50% trichloroacetic acid (TCA) and fractional CO_2 laser in the management of XP, with emphasis on lesion clearance dynamics, final outcomes, and comparative effectiveness.

Both treatment groups were well matched at baseline. The mean age was 34.6 ± 14.2 years in the TCA group and 32.9 ± 10.1 years in the laser group ($p = 0.58$), consistent with reports by Goel et al.[9], Al-Kady et al.[18], Arora et al.[21], and Ramteke et al.[17] where most patients fell in the third and fourth decades. Female predominance was noted in both groups (57.1% and 60.7%, respectively; $p = 0.79$), mirroring findings of Al-Zou et al.[19], Li et al.[8], and Nassief et al.[14], likely reflecting hormonal influences and greater cosmetic concern among females. Baseline lesion size was significantly larger in the laser group (7.96 ± 2.8 mm vs. 6.29 ± 2.1 mm; $p = 0.013$); yet, despite this disadvantage, laser outcomes remained superior — corroborating Das et al.[16] and Wang et al.[23], who noted sustained laser efficacy even with larger lesions.

One of the most striking findings was the significantly faster lesion clearance with fractional CO_2 laser at every sitting. After sitting 1, mean clearance was 45.3% (laser) versus 15.3% (TCA; $p < 0.001$), rising to 68.0% vs. 30.9% at sitting 2, and 84.1% vs. 58.3% at sitting 4 (all $p < 0.001$). This rapid response reflects the laser's ability to achieve immediate vaporization of lipid deposits and controlled thermal injury, stimulating collagen remodeling and re-epithelialization. By contrast, TCA acts through protein coagulation and gradual epidermal necrosis — a slower, concentration-dependent process. Mourad et al.[10] noted that while higher TCA concentrations (70%) improve efficacy, they increase erythema and hypopigmentation, underscoring the safety-efficacy trade-off. Goel et al.[9] similarly demonstrated that CO_2 laser required far fewer sessions (mean 1.56) compared to TCA (mean 9.74), and Tuan et al.[13] reported ≥75% clearance in 82% of laser-treated patients within 3–4 sessions.

Final percentage clearance further confirmed the superiority of fractional CO_2 laser. Mean final clearance was 84.1 ± 8.9% in the laser group versus 58.25 ± 6.4% in the TCA group ($p < 0.001$). More than half of laser-treated patients achieved ≥80% clearance, whereas none in the TCA group reached this threshold. On outcome scoring, 89.3% of laser patients achieved an excellent response (Score 4) compared to none in the TCA group, where 89.3% achieved a good response (Score 3) and 10.7% showed moderate improvement ($p < 0.001$). These results align with Ramteke et al.[17] (86% complete resolution with ultrapulse CO_2 laser), Al-Zou et al.[19] (75.9% excellent outcomes), (100% excellent or very good improvement with CO_2 laser). In contrast, TCA outcomes vary markedly with concentration — Nassief et al.[14] reported excellent clearance in 94.1% with 70% TCA versus 14.7% with 30% TCA, while Sapra et al.[22] noted 97.2% improvement with 80% TCA but a 24.7% recurrence rate, reinforcing that mid-strength TCA is safer yet less efficacious.

Comparative studies involving alternative modalities provide further context. Reddy et al.[11] found that radiofrequency ablation achieved faster clearance than TCA but with higher scarring rates (40%), while Tahir et al.[12] demonstrated superior

efficacy of 100% TCA over cryotherapy (75% vs. 17.5%), albeit with considerable safety concerns at such concentrations. Combination approaches have also shown promise — Iraji et al.[15] reported enhanced outcomes with CO_2 laser combined with 50% TCA, and Ali et al.[20] observed faster healing and lower scar scores when either modality was combined with intralesional sodium stibogluconate, suggesting that multimodal strategies may further optimize results in selected cases. Al-Kady et al.[18] and Arora et al.[21] similarly reported higher complete clearance rates (70% vs. 25%), greater patient satisfaction, and shorter downtime with laser over TCA.

Although recurrence was not assessed in the present study due to limited follow-up, existing evidence favors laser therapy. Das et al.[16] reported recurrence rates of 6–11% with CO_2 laser versus 17–24% with TCA, and Wang et al.[23] reported only 6.8% recurrence in 295 patients treated with CO_2 laser excision. Li et al.[8] noted higher recurrence with multiple lesions, highlighting the role of lesion burden in long-term prognosis. From a clinical standpoint, while 50% TCA remains a cost-effective option for small or superficial lesions, fractional CO_2 laser offers faster clearance, superior outcomes, and greater cosmetic satisfaction even in larger lesions, consistent with the systematic review by Malekzadeh et al.[4] identifying CO_2 laser as among the most effective non-surgical modalities for XP. In conclusion, the present study confirms that both modalities are effective for XP management; however, fractional CO_2 laser demonstrates significantly superior efficacy, faster clearance, higher rates of excellent outcomes, and better cosmetic results — strongly supporting its preferential use, particularly in patients with moderate-to-severe disease or those seeking rapid and cosmetically optimal outcomes. Future multicentric RCTs with standardized parameters, objective scoring, and long-term follow-up are warranted to further refine treatment algorithms.

CONCLUSION

The present study demonstrates that both 50% trichloroacetic acid (TCA) and fractional CO_2 laser are effective modalities for the management of xanthelasma palpebrarum; however, significant differences exist in their therapeutic outcomes. Fractional CO_2 laser consistently exhibited faster lesion clearance, higher final clearance rates, and superior clinical outcomes compared to TCA. A greater proportion of patients treated with laser achieved excellent responses, along with better cosmetic satisfaction, even in cases with relatively larger lesions.

In contrast, 50% TCA, although effective, showed comparatively slower and less pronounced improvement. Its role remains relevant as a cost-effective and accessible option, particularly for smaller and superficial lesions or in resource-limited settings. However, the efficacy–safety balance with TCA appears to be concentration-dependent, limiting its performance at moderate strengths.

Overall, fractional CO_2 laser emerges as the more effective and preferable treatment modality for xanthelasma palpebrarum, especially in patients requiring rapid clearance and optimal aesthetic outcomes. Further large-scale, multicentric studies with long-term follow-up are recommended to validate these findings and establish standardized treatment protocols.
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REFERENCES

1. Nair PA, Singhal R. Xanthelasma palpebrarum: a brief review. Clin Cosmet Investig Dermatol. 2017;10:1–5.
2. Bergman R. The pathogenesis and clinical significance of xanthelasma palpebrarum. J Am Acad Dermatol. 1994;30(2):236–42.
3. Lustig-Barzelay Y, Kapelushnik N, Goldshtein I, Leshno A, Segev S, Ben-Simon GJ, Landau-Prat D. Association between xanthelasma palpebrarum with cardiovascular risk and dyslipidemia: a case-control study. Ophthalmology. 2025;132(2):164–9.
4. Malekzadeh H, Ormseth B, Janis JE. A practical review of the management of xanthelasma palpebrarum. Plast Reconstr Surg Glob Open. 2023;11(5):e4982.
5. Cannon PS, Ajit R, Leatherbarrow B. Efficacy of trichloroacetic acid (95%) in the management of xanthelasma palpebrarum. Clin Exp Dermatol. 2010;35(8):845–8.
6. Esmat SM, Elramly AZ, Halim DM, Gawdat HI, Taha HI. Fractional CO_2 laser is an effective therapeutic modality for xanthelasma palpebrarum: a randomized clinical trial. Dermatol Surg. 2014;40(12):1349–55.
7. Nguyen AH, Vaudreuil AM, Huerter CJ. Systematic review of laser therapy in xanthelasma palpebrarum. Int J Dermatol. 2017;56(3):e47–55.
8. Li D, Lin SB, Cheng B. CO_2 laser treatment of xanthelasma palpebrarum in skin types III–IV: efficacy and complications after 9-month follow-up. Photobiomodul Photomed Laser Surg. 2019;37(4):244–7.

9. Goel K, Sardana K, Sehgal VN, Sharma S. A prospective study comparing ultrapulse CO_2 laser and trichloroacetic acid in treatment of xanthelasma palpebrarum. J Cosmet Dermatol. 2015;14(2):130–9.
10. Mourad B, Labeeb AZ, Abdel Hay R, El Nabarawy E, Yousef DC. Assessment of efficacy and tolerability of different concentrations of trichloroacetic acid versus carbon dioxide laser in treatment of xanthelasma palpebrarum. J Cosmet Dermatol. 2015;14(3):209–15.
11. Reddy P, Jha AK, Gupta S. Comparative study to evaluate the efficacy of radiofrequency ablation versus trichloroacetic acid in the treatment of xanthelasma palpebrarum. J Cutan Aesthet Surg. 2016;9(4):236–40.
12. Tahir M, Raza N, Kazmi AH, Waheed A, Tariq S. A prospective, split-face, randomized, open-label study comparing efficacy of trichloroacetic acid (100%) and cryotherapy in xanthelasma palpebrarum. J Pak Assoc Dermatol. 2017;27(1):59–63.
13. Tuan H, Ho SG, Nguyen T, Pham T. A comparison of the efficacy and safety of fractional CO_2 laser and fractional Er:YAG laser for the treatment of xanthelasma palpebrarum: a randomized split-face controlled trial. J Invest Dermatol. 2018;138(Suppl 1):S79.
14. Nassief M, Hassan A, Abdel-Malek R, El-Badawy N. Therapeutic efficacy and tolerability of 30% versus 70% concentrations of topical trichloroacetic acid in patients with xanthelasma palpebrarum: a randomized clinical trial. Minia J Med Res. 2019;30(4):86–92.
15. Iraji F, Faghihi G, Ghafoorzadeh M, Rezaei M, Hejazi SH. Combination of continuous wave CO_2 laser and topical application of trichloroacetic acid 50% in treatment. J Cosmet Dermatol. 2020;19(6):1367–70.
16. Das NM, Subramaniyan R, Arora S, Dabas R, Janney MS, Lal SV. Efficacy of ultrapulse carbon dioxide laser ablation versus 30% trichloroacetic acid in xanthelasma palpebrarum: a randomized controlled trial. J Mar Med Soc. 2021;23(2):196–200.
17. Ramteke M, Dhurat R, Patil S, Wankhede P. A prospective interventional study of xanthelasma palpebrarum treated with ultrapulse carbon dioxide laser. J Clin Diagn Res. 2021;15(8):WC04–7.
18. Al-Kady NA, Elfar NN, El-Mohamady MF, El-Samadony HA. Fractional CO_2 laser versus trichloroacetic acid 50% for xanthelasma palpebrarum therapy. J Cosmet Dermatol. 2021;20(3):763–8.
19. Al-Zou AB, Saleh AHA, Algaradi KH, Elkasah F. CO_2 laser treatment of xanthelasma palpebrarum in skin. Sirte J Med Sci. 2022;1(1).
20. Ali SM, El-Khalawany M, Ahmed AM, Hassan AA, Abdelhalim DM. Effect of intralesional sodium stibogluconate alone versus combinations with topical trichloroacetic acid 50% or fractional CO_2 laser. Indian J Dermatol. 2023;68(5):588.
21. Arora A, Arora S, Gupta S, Kumar S, Sharma R. Clinical and dermatoscopic perspective of erbium:YAG laser ablation versus 50% trichloroacetic acid. J Cutan Aesthet Surg. 2024;17(1):1–6.
22. Sapra S, Tran JV, Gurm H, Eleuterio M. Treatment of xanthelasma palpebrarum using trichloroacetic acid 80%. J Clin Aesthet Dermatol. 2024;17(11):17–22.
23. Wang D, Mao Z, Li Z, Gao W, Qu Y, Li X, Jiang Y, Lin X. Carbon dioxide laser excision as a novel treatment for large xanthelasma palpebrarum: long-term efficacy and safety. Br J Ophthalmol. 2025;109(3):427–32.
24. Batool A, Tahir R, Bakhtawar A, Tahir S, Iqbal S, Ahmed A, Jamil M. Efficacy of trichloroacetic acid versus cryotherapy in patients with xanthelasma palpebrarum: a randomized controlled trial. Pak J Health Sci. 2025;6(8).