Portuguese Journal of Dermatology and Venereology

Permanyer

Check for updates

Port J Dermatol and Venereol.

ORIGINAL ARTICLE

Efficacy of ablative carbon dioxide laser in management of xanthelasma palpebrarum

Eficácia do laser ablativo de dióxido de carbono no tratamento do xantelasma palpebrarum

Geetanjali Jangra[1], Guneet Awal[1], Saurabh Sharma[1] Amandeep Singh[2] and Roopam Bassi[3]*

[1]Department of Dermatology; [2]Department of Radiodiagnosis; [3]Department of Physiology. Sri Guru Ram Das Institute of Medical Sciences and Research, Punjab, India

Abstract

Objectives: The objective of the study is to evaluate the efficacy and safety of ablative carbon dioxide (CO_2) laser in the treatment of xanthelasma palpebrarum. **Methods:** This interventional study included 90 patients aged 18-65 years with grade I-III xanthelasma. Patients with grade IV lesions and significant comorbidities were excluded. Baseline clinical and biochemical evaluation was performed. Lesions were treated with ablative CO_2 laser using standardized parameters (60-90 mJ energy, 210 Hz frequency). Patients were followed up monthly for 3 months. Efficacy was assessed using five-point scale score and patient satisfaction score. **Results:** Most patients were females (85.6%) and belonged to the 25-45-year age group (54.4%). Upper eyelid involvement was predominant (97.8%). Progressive improvement in lesion clearance was observed with > 75% clearance achieved in 56.7% patients at 3 months (p = 0.001). At the end of the study, 72.2% patients were very satisfied. Common adverse effects included erythema, edema, and scabbing. Hypopigmentation was the most frequent complication (65.6%), while recurrence occurred in 5.6% cases. **Conclusion:** Ablative CO_2 laser is a safe and effective treatment modality for xanthelasma palpebrarum, offering good cosmetic outcomes with high patient satisfaction and low recurrence rates.

Keywords: Ablative. Carbon dioxide laser. Hyperlipidemias. Laser therapy. Recurrence. Treatment outcomes. Xanthelasma palpebrarum.

Resumo

Objectivo: Avaliar a eficácia e a segurança do laser ablativo de CO_2 no tratamento do xantelasma palpebrarum. **Métodos**: Este estudo intervencional incluiu 90 doentes com idades compreendidas entre os 18 e os 65 anos, apresentando xantelasma de graus I a III. Foram excluídos os doentes com lesões de grau IV e comorbilidades significativas. Foi realizada uma avaliação clínica e bioquímica basal. As lesões foram tratadas com laser ablativo de CO2, utilizando parâmetros padronizados (energia de 60-90 mJ; frequência de 210 Hz). Os doentes foram acompanhados mensalmente durante três meses. A eficácia foi avaliada através de uma escala de pontuação de 5 pontos e de um score de satisfação do doente. **Resultados**: A maioria dos doentes era do sexo feminino (85,6%) e pertencia ao grupo etário dos 25 aos 45 anos (54,4%). O envolvimento da pálpebra superior foi predominante (97,8%). Observou-se uma melhoria progressiva na eliminação das lesões, tendo sido atingida uma taxa de eliminação superior a 75% em 56,7% dos doentes aos 3 meses (p = 0,001). No final

Correspondence:
Guneet Awal
E-mail: guneetawal@gmail.com

Received: 18-04-2026
Accepted: 06-06-2026
DOI: 10.24875/PJDV.260000491

Available online: 08-07-2026
Port J Dermatol and Venereol. (ahead of print)
www.portuguesejournalofdermatology.com

do estudo, 72,2% dos doentes estavam muito satisfeitos. Os efeitos adversos comuns incluíram eritema, edema e formação de crostas. A hipopigmentação foi a complicação mais frequente (65,6%), enquanto a recidiva ocorreu em 5,6% dos casos. **Conclusões**: O laser ablativo de CO2 constitui uma modalidade de tratamento segura e eficaz para o xantelasma palpebrarum, proporcionando bons resultados estéticos, com elevado grau de satisfação do paciente e baixas taxas de recorrência.

Palavras-chave: Ablativo. Hiperlipidemias. Laser de dióxido de carbono. Laserterapia. Recidiva. Resultados do tratamento. Xantelasma palpebrarum.

Introduction

Xanthomas are yellowish lesions formed by the deposition of lipid-laden macrophages within the skin, subcutaneous tissue, or tendons. They are widely recognized as visible cutaneous indicators of underlying disturbances in lipid metabolism and are commonly associated with dyslipidemias such as familial hypercholesterolemia and hyperbetalipoproteinemia.[1,2] In addition to primary lipid disorders, xanthomas may also be seen in association with systemic conditions including diabetes mellitus, hypothyroidism, nephrotic syndrome, and other endocrine or metabolic abnormalities.[3,4]

Among the different clinical variants, xanthelasma palpebrarum is the most frequently encountered type and is characterized by soft, yellowish plaques occurring over the eyelids, most often near the medial canthus. Although these lesions are benign and usually asymptomatic, they are a common cosmetic concern for patients due to their prominent facial location. Furthermore, xanthelasma has been increasingly recognized as a potential marker of underlying dyslipidemia and an indicator of increased cardiovascular risk, even in individuals without overt lipid abnormalities.[5,6] The condition is seen more commonly in middle-aged adults, with a higher prevalence among females, and often presents with bilateral involvement of the upper eyelids.[7]

The management of xanthelasma palpebrarum remains challenging, primarily because of its tendency to recur and the need to achieve optimal cosmetic results in the delicate periorbital region. Conventional treatment options include surgical excision, chemical cauterization using agents such as trichloroacetic acid, cryotherapy, and electrosurgery. While surgical excision can be effective, it is not without limitations, particularly in patients with large or multiple lesions, as it may result in scarring, eyelid deformity, or prolonged healing time.[8,9]

With advances in dermatologic technology, minimally invasive energy-based modalities have gained popularity for the treatment of xanthelasma palpebrarum. Radiofrequency ablation and carbon dioxide (CO_2) laser therapy are among the most commonly used techniques. Radiofrequency ablation works by delivering high-frequency electrical current to produce localized thermal destruction of tissue, whereas ablative CO_2 laser therapy achieves precise tissue vaporization through selective absorption by water within the cells, allowing controlled ablation with excellent hemostasis.[10,11] These modalities offer the advantages of reduced intraoperative bleeding, shorter procedure time, and improved cosmetic outcomes compared to conventional surgical approaches.

In cases of extensive, thick, or recurrent xanthelasma, radiofrequency and CO_2 laser therapies have also been used either alone or as adjuncts to surgical excision, helping to reduce the number of treatment sessions and enhance esthetic results.[12] Despite these advances, recurrence continues to be a concern, particularly in patients with persistent dyslipidemia or poorly controlled metabolic disorders, emphasizing the importance of both effective lesion clearance and systemic evaluation.[13,14]

The present study was undertaken to evaluate the efficacy and safety of ablative CO_2 laser therapy in the management of xanthelasma palpebrarum. The study focuses on assessing lesion clearance, number of treatment sessions required, healing time, complication profile, patient satisfaction, and recurrence rates.

Methods

This interventional study was conducted among clinically diagnosed cases of xanthelasma palpebrarum. A total of 70 patients were enrolled in the study, conducted from July 2024 to December 2025. Patients aged 18-65 years presenting with grade I-III xanthelasma palpebrarum involving the upper and/or lower eyelids and with no history of topical treatment for xanthelasma in the preceding 6 months were included in the study. Patients with Grade IV xanthelasma, bleeding disorders, active herpetic infection in the periorbital area, keloidal tendency, poor glycemic control, a history of pacemaker implantation, or those receiving

anticoagulant or corticosteroid therapy were excluded from the study. Demographic data and clinical details were obtained using a structured pro forma. Prior to treatment, a detailed clinical examination was performed, recording site, size and grades of all lesions. After ethics approval (SGRD/IEC/2024-381) and informed consent, baseline investigations including complete blood count, lipid profile, and viral markers were carried out, along with digital photography of the periorbital area of patients before the intervention. The data were collected and compiled using a semi-structured interview schedule. The data were collected and compiled in MS Excel sheet and analyzed using the Statistical Package for the Social Sciences version 26. Following assessment, xanthelasma lesions located on the eyelids were treated using an ablative CO_2 laser. The treatment area was cleaned with povidone-iodine, and local anesthesia was administered through infiltration of 2% lignocaine around the lesion. Repeat treatment sessions were performed when necessary. Ablation was performed using a CO_2 laser in stamping mode with surgical and scatter patterns. Laser parameters were set with energy range of 60-90 mJ, frequency of 210 Hz, pulse duration of 2-3 ms, and a period of 10 ms. The procedural endpoint was identified by the appearance of uniform pinkish underlying dermis, indicating adequate ablation and disappearance of characteristic yellowish plaques.

Patients were followed up monthly for 3 months to assess lesion clearance, patient satisfaction, and occurrence of adverse effects such as hypopigmentation, hyperpigmentation, scarring, ectropion, and recurrences. Post-procedure care included application of 2% mupirocin ointment along with strict photoprotection for 1 week until re-epithelialization of the treatment area.

Treatment efficacy was assessed using a 5-point scale:[15]

– Score 0: No results
– Score 1: Mild results (< 25% clearing)
– Score 2: Moderate results (25-50% clearing)
– Score 3: Good results (50-75% clearing)
– Score 4: Excellent results (more than 75% clearing).

Patient response to treatment was recorded monthly using a patient satisfaction score (PSS), rated as follows:[16]

– 5 points: Very satisfied
– 4 points: Somewhat satisfied
– 3 points: Neither satisfied nor dissatisfied
– 2 points: Somewhat dissatisfied
– 1 point: Very dissatisfied.

Results

A total of 90 patients with xanthelasmas on the eyelid were included in the study. All enrolled patients completed the 3-month follow-up period. Majority (85.6%) of participants were female. 54.4% of patients were in the 25-45 year age group and 8.9% were > 65 years (Fig. 1). In 97.8% of patients, lesions were present on the upper eyelid, whereas in 2.2% were present on the lower eyelid. 98.9% of patients had two lesions, whereas 1.1% had three lesions. In 42.2% of patients, lesions were of grade 3, followed by grade 1 (28.9%) and grade 2 (28.9%). 55.6% of patients were on statin therapy (Table 1). Mean levels of total cholesterol, low-density lipoprotein (LDL) cholesterol, and triglycerides were 224.02 mg/dL, 141.36 mg/dL, and 161.4 mg/dL with elevation, respectively, in 70%, 56.7%, and 52.2%.

There were statistically significant changes in clearance at 3 months compared to 1 month. 35.6 % of patients had 50-75% clearance at 1-month follow-up, whereas at 3 months, 54.2% of patients had > 75% clearance (Table 2 and Fig. 2 and 3). Table 3 describes the follow-up findings after 1st week. 70% of the patients developed erythema, 51.1% edema, 55.6% scabbing while only 12.2% patients had pain lasting for 1 week after CO_2 laser treatment. Hypopigmentation was observed in 65.6% of patients but it resolved with pimecrolimus 1% ointment in 56.7% patients.

At the end of 3 months, PSS with the results of the procedure was very satisfied in 72.2%, whereas only 1.1% of patients were somewhat dissatisfied with the results (Table 4 and Fig. 4).

In 5.6% of patients, a recurrence was observed (Table 5). Total cholesterol, LDL, and triglyceride were abnormal in 11.1%, 11.4%, and 8.8% of the patients who had recurrence; however, this association was not statistically significant (Table 6).

Discussion

This study shows that the ablative CO_2 laser is an effective treatment modality in the management of xanthelasma palpebrarum. The CO_2 laser emits infrared radiation at a wavelength of 10,600 nm, which is strongly absorbed by water within skin tissues. This property allows precise vaporization of target tissue with excellent hemostasis. Xanthelasma palpebrarum represents the most frequent cutaneous xanthoma encountered in dermatological practice and is often associated with underlying lipid abnormalities. This interventional study

Table 1. Demographic details of study patients

Variables	Frequency	Percentage
Age group		
25-45	49	54.4
46-65	33	36.7
>65	8	8.9
Gender		
Female	77	85.6
Male	13	14.4
Site of lesion		
Lower eyelid	2	2.2
Upper eyelid	88	97.8
Number of lesion		
2	89	98.9
3	1	1.1
Grade		
1	26	28.9
2	26	28.9
3	38	42.2
Statin therapy		
Yes	50	55.6
No	40	44.4

Table 2. Percentage of clearance at 1, 2, and 3 months

Time point	< 25%	25-50%	50-75%	> 75%	p-value
1 month	4 (4.4)	53 (58.9)	30 (33.3)	3 (3.3)	0.001
2 months	0 (0)	60 (66.7)	30 (33.3)	0 (0)	0.001
3 months	0 (0)	1 (1.1)	38 (42.2)	51 (56.7)	0.001

Table 3. Follow-up at 1-week post-treatment

Week 1 follow-up findings	CO_2 laser (%)
Erythema	63 (70)
Edema	46 (51.1)
Scabbing	50 (55.6)
Pain	11 (12.2)

CO_2: carbon dioxide.

Table 4. Patient satisfaction score after the last treatment session

Time point	Patient satisfaction score				
	1	2	3	4	5
3 months	0 (0)	1 (1.1)	6 (6.7)	18 (20.0)	65 (72.2)

Table 5. Side effects after 3-month post-treatment

Side effects	Frequency	Percentage
Hypopigmentation	59	65.6
Recurrence	5	5.6

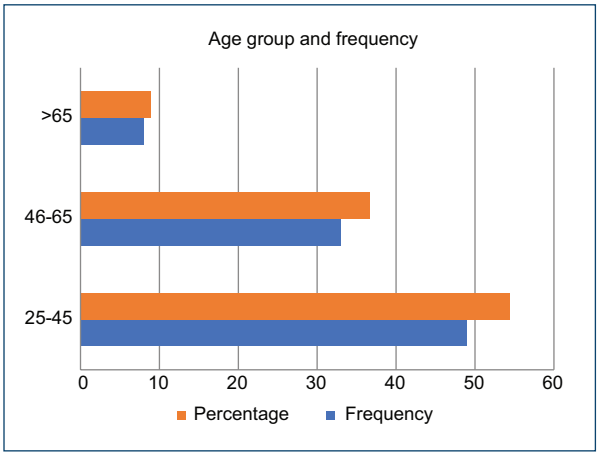

Figure 1. Age group distribution of study patients.

evaluated the clinical efficacy, safety profile, and patient satisfaction associated with ablative CO_2 laser therapy in patients with xanthelasma palpebrarum. 33.3% of patients noticed good results after the first session, whereas complete resolution after 3 sessions was observed in 56.7% of patients. The most common side effect was post-inflammatory hypopigmentation, which was also the common finding in few other studies.[11,12] In our study, we added topical pimecrolimus for the resolution though longer follow-up is required to determine the complete resolution of this side effect.

Employing pulsed or ultrapulsed modalities at energy parameters of 60-90 mJ per pulse, pulse widths of 2-3 ms, and a stamping technique applied until the visualization of pink dermis, we acheived 90-100% clearance in a single session, with recurrence rate of 3.8% in grade 2 xanthelasma and 10.5% in grade 3 lesions, which is lower than the recurrence rate reported by Li et al. (50%)[17] and Pathania and Chatterjee (20%).[18]

In the current study, the majority of patients belonged to the 25-45-year age group, with a clear female

Table 6. Describes the recurrence of CO_2 laser with cholesterol levels

Recurrence	Total cholesterol		Triglycerides		LDL	
	Normal	Abnormal	Normal	Abnormal	Normal	Abnormal
No	40	45	51	34	50	35
Yes	0	5	2	3	1	4
p-value	0.142		0.74		0.257	

CO_2: carbon dioxide; LDL: low-density lipoprotein.

Figure 2. Pre and post-treatment images of patients.

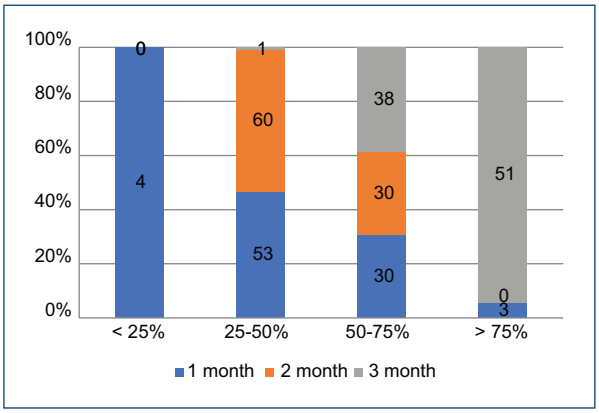

Figure 3. Percentage of clearance at 1, 2, and 3 months.

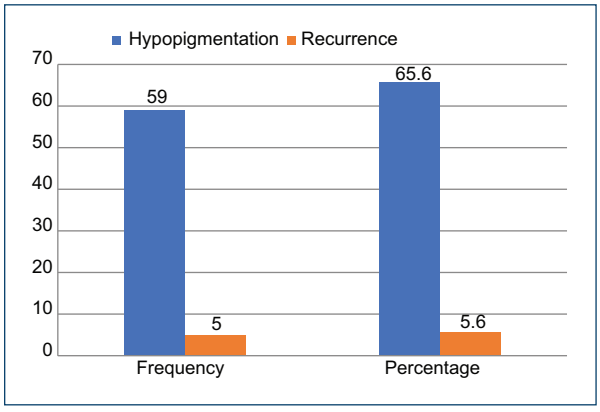

Figure 4. Side effects at 3-month post-therapy.

preponderance. This demographic pattern has been consistently reported in earlier studies, suggesting that hormonal influences, cosmetic awareness, and health-seeking behavior may contribute to higher reporting among females.[3] Similar age distribution and female predominance have been observed by Pathania and Chatterjee, reinforcing that xanthelasma is most frequently diagnosed in early to middle adulthood.[11,18] A strong association between xanthelasma and dyslipidemia was evident in the present study. Mean levels of total cholesterol, triglycerides, and LDL cholesterol were elevated, while high-density lipoprotein cholesterol remained within normal limits. These findings corroborate previous reports indicating that xanthelasma may serve as a visible marker of underlying lipid metabolism disorders, particularly hypercholesterolemia and mixed dyslipidemia.[5,6] The process of an increase in permeability of vascular walls allows circulating lipoprotein to extravasate into the dermis. Monocytes and macrophages play an essential role in engulfing lipid particles and transforming them into lipid-laden foam cells. Studies by Mourad et al. and Chatterjee similarly documented abnormal lipid profiles in a substantial proportion of patients with xanthelasma, underscoring the importance of metabolic evaluation in these patients.[8,13] Although 55.6% of patients in the present study were receiving statin therapy, lesion persistence suggests that xanthelasma may not regress despite

biochemical lipid control, as also noted in earlier literature.[8,11]

Clinically, the upper eyelid was the most commonly involved site,[13,19] with bilateral involvement and two lesions being the predominant presentation. It seldom results in functional issues such as impaired vision, and treatment is typically pursued due to esthetic concerns. This distribution pattern is in agreement with multiple published studies, where the medial aspect of the upper eyelid has been described as the most frequent site due to local anatomical and vascular factors.[5] A higher proportion of patients (42.2%) in the present study had grade 3 lesions, indicating relatively advanced disease at presentation, possibly due to delayed cosmetic consultation.

With respect to therapeutic outcomes, ablative CO_2 laser therapy demonstrated progressive and significant lesion clearance over time. At 1-month follow-up, only 3.3% of patients achieved more than 75% clearance; however, this proportion increased markedly to 56.7% at 3 months, as shown in Fig. 1. This delayed yet progressive improvement can be attributed to post-laser tissue remodeling and re-epithelialization, a phenomenon well documented with CO_2 laser resurfacing techniques.[10] Similar clearance rates have been reported by Ullmann et al., who highlighted the efficacy of CO_2 laser in achieving satisfactory cosmetic outcomes, particularly in larger or thicker lesions.[10] Similar study conducted by Wang et al. which used CO_2 as a modality for large excision of xanthelasma lesions concluded clearance rate of more than 99%.[20]

Non-ablative treatment modalities are considered better in minimizing post-treatment scarring as they target only superficial epidermis while sparing deeper dermal structures. This limited depth of penetration results in controlled tissue damage and promotes favorable healing. Although ablative lasers such as CO_2 lasers are widely utilized for treatment of xanthelasma, several other modalities such as pulse dye laser have been widely used in the past for treatment of xanthelasma palpebrarum. A study evaluating the use of pulse dye laser demonstrated a clearance rate of 90-100% after four treatment sessions, with minimal evidence of post-treatment scarring. Furthermore, no recurrence was reported at the 2-month follow-up period.[21] Other non-ablative lasers such as Nd YAG[22] and KTP[23] lasers have also been employed.

Patient satisfaction was notably high in the present study, with over two-thirds of patients reporting being "very satisfied" at 3 months. High satisfaction scores have been consistently associated with CO_2 laser therapy due to precise tissue ablation, minimal bleeding, and favorable cosmetic results.[9,10] Such outcomes are particularly relevant for periorbital lesions, where esthetic considerations are paramount.

Surgical incision, the oldest method for xanthelasma treatment, is associated with a greater risk of scarring and ectropion. In a study by Roux et al., involving modified blepharoplasty incision in xanthelasma, they reported 4.2% scarring in 66 patients.[24] Ullmann et al. reported that lesions undergo re-epithelialization within 7-10 days with post-therapy erythema that resolves after 3 months.[9] Raulin et al. reported persistent erythema for 2-4 months with the use of Ultrapulsed CO_2 laser in xanthelasma.[25] Mild hypopigmentation that did not significantly affect patient satisfaction affected 65.6% of patients, whereas in comparable studies, it was lower, ranging from 13 to 24%.[9,25] Post-inflammatory pigmentary changes are a recognized complication of ablative laser procedures, especially in individuals with darker skin phototypes.[10,12]

Recurrence emerged out as a common outcome in the treatment of xanthelasma despite variable treatment options. In the present study, 5.6% patients had recurrence, lower than or comparable to earlier studies, ranging from 9% to 40%, and depending on treatment modality and follow-up duration.[9,13] Persistent dyslipidemia and incomplete lesion ablation are considered major contributors to recurrence. However, in our study, there is no correlation between xanthelasma recurrence and abnormal cholesterol levels, as in the study by Raulin et al., who concluded that recurrence is typically due to incomplete vaporization of deep dermal foam cells rather than patient's systemic lipid status.[25]

Mourad et al. in 2015 demonstrated that CO_2 laser required fewer treatment sessions with superior cosmetic outcomes compared to TCA application and that fractional CO_2 laser yielded better patient satisfaction than super-pulsed CO_2 despite equivalent clearance rates.[19]

Al-Kady et al. (2021) in a comparative interventional prospective study involving 20 adult patients with xanthelasma, there was no statistical difference between treatment with fractional CO_2 laser (10,600 nm) and 50% TCA in which concerns safety, efficacy, and downtime.[26]

A systematic review conducted by Cisneros, which analyzed 50 studies on the treatment of eyelid xanthelasma from 1993 to 2022, none of the treatments received a Grade A recommendation based on the Scottish Intercollegiate Guidelines Network criteria. However, ablative laser treatments (CO_2 10600 nm and Er: YAG 2940 nm), whether fractionated or not, received a Grade B recommendation alongside with Q-switched Nd: YAG 1064 nm laser, radiofrequency, and topical

TCA at 30-100% concentrations. Laser treatments, particularly CO_2 and Er: YAG, stand out as effective alternatives to surgery, despite potential side effects such as pain, persistent erythema, eyelid inflammation, dyschromia, and scarring.[27]

Overall, the findings of the present study support ablative CO_2 laser as an effective and well-tolerated treatment modality for xanthelasma palpebrarum, offering high clearance rates, excellent patient satisfaction, and a low recurrence rate when appropriately selected.

Limitations of this study are the relatively small sample size, the shorter follow-up period of 3 months, and lack of documentation of size and depth of the lesions. Further research with longer follow-ups and large sample size is required.

Conclusion

Ablative CO_2 laser is a safe, effective, and good therapeutic alternative for xanthelasma palpebrarum, with higher clearance rates, high patient satisfaction, and lesser adverse effects. Based on the findings in this study, its use is especially recommended in lesions of redundant upper eyelids and those occupying large surface area for a better cosmetic outcome.

Funding

None.

Conflicts of interest

None.

Ethical considerations

Protection of human subjects and animals. The authors declare that no experiments on humans or animals were performed for this research.

Confidentiality, informed consent, and ethical approval. The authors have followed their institution's confidentiality protocols, obtained informed consent from all patients, and secured approval from the Ethics Committee. SAGER guidelines have been followed as applicable to the nature of the study.

Declaration on the use of artificial intelligence (AI). The authors declare that no generative artificial intelligence was used in the writing or creation of the content of this manuscript.

References

1. Bergman R. Xanthomas and xanthelasmas: diagnosis and management. Dermatol Clin. 1995;13:1-11.
2. Fredrickson DS, Levy RI, Lees RS. Fat transport in lipoproteins--an integrated approach to mechanisms and disorders. N Engl J Med. 1967;276:34-42.
3. Parker F. Xanthomas and hyperlipidemias. J Am Acad Dermatol. 1985;13:1-30.
4. Zak A, Zeman M, Slaby A, Vecka M. Xanthomas: clinical and pathophysiological relations. Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub. 2014;158:181-8.
5. Christoffersen M, Frikke-Schmidt R, Schnohr P, Jensen GB, Nordestgaard BG, Tybjærg-Hansen A. Xanthelasmata, arcus corneae, and ischaemic vascular disease and death in general population: prospective cohort study. BMJ. 2011;343:d5497.
6. Pandhi D, Gupta P, Singal A, Tondon A, Sharma S, Madhu SV. Xanthelasma palpebrarum: a marker of premature atherosclerosis (risk of atherosclerosis in xanthelasma). Postgrad Med J. 2012;88:198-204.
7. Jain A, Goyal P, Nigam PK. Xanthelasma palpebrarum-clinical and biochemical profile. J Assoc Physicians India. 2007;55:379-81.
8. Rohrich RJ, Janis JE, Pownell PH. Xanthelasma palpebrarum: a review and current management principles. Plast Reconstr Surg. 2002;110:1310-4.
9. Ullmann Y, Har-Shai Y, Peled IJ. The use of CO2 laser for the treatment of xanthelasma palpebrarum. Ann Plast Surg. 1993;31:504-7.
10. Fitzpatrick RE, Goldman MP, Satur NM, Tope WD. Pulsed carbon dioxide laser resurfacing of photo-aged facial skin. Arch Dermatol. 1996;132:395-402.
11. Moon YJ, Yun SK, Kim HU, Ihm CW. The use of CO2 laser for the treatment of xanthelasma palpebrarum in Korea. Korean J Dermatol. 2004;42:250-5.
12. Manuskiatti W, Fitzpatrick RE, Goldman MP. Long-term effectiveness and side effects of carbon dioxide laser resurfacing for photoaged facial skin. J Am Acad Dermatol. 1999;40:401-11.
13. Mourad B, Elgarhy LH, Ellakkawy HA, Elmahdy N. Assessment of efficacy and tolerability of different concentrations of trichloroacetic acid vs. Carbon dioxide laser in treatment of xanthelasma palpebrarum. J Cosmet Dermatol. 2015;14:209-15.
14. Hojman L, Karsulovic C. Cardiovascular disease-associated skin conditions. Vasc Health Risk Manag. 2022;18:43-53.
15. Dincer D, Koc E, Erbil AH, Kose O. Effectiveness of low-voltage radiofrequency in the treatment of xanthelasma palpebrarum: a pilot study of 15 cases. Dermatol Surg. 2010;36:1973-8.
16. Das NM. A Comparative Study on the Efficacy of Carbon Dioxide (CO2) Laser Ablation Vs 30% Trichloroacetic Acid (Tca) Peel in the Treatment of Xanthelasma Palpebrarum. [Doctoral dissertation] Rajiv Gandhi University of Health Sciences (India);2019.
17. Li D, Lin SB, Cheng B. CO2 laser treatment of xanthelasma palpebrarum in skin types III-IV: efficacy and complications after 9-month follow-up. Photobiomodul Photomed Laser Surg. 2019;37:244-7.
18. Pathania V, Chatterjee M. Ultrapulse carbon dioxide laser ablation of xanthelasma palpebrarum: a case series. J Cutan Aesthet Surg. 2015;8:46-9.
19. Bergman R, Kasif Y, Aviram M, Maor I, Ullman Y, Gdal-On M, et al. Normolipidemic xanthelasma palpebrarum: lipid composition, cholesterol metabolism in monocyte-derived macrophages, and plasma lipid peroxidation. Acta Derm Venereol. 1996;76:107-10.
20. Wang D, Mao Z, Li Z, Gao W, Qu Y, Li X, et al. Carbon dioxide laser excision as a novel treatment for large xanthelasma palpebrarum: long-term efficacy and safety. Br J Ophthalmol. 2025;109:427-32.
21. Thajudheen CP, Jyothy K, Arul P. Treatment of xanthelasma palpebrarum using pulsed dye laser: original report on 14 cases. J Cut Aesth Surg. 2019;12:193-5.
22. Heng JK, Chua SH, Goh CL, Cheng S, Tan V, Tan WP. Treatment of xanthelasma palpebrarum with a 1064-nm, Q-switched Nd: YAG laser. J Am Acad Dermatol. 2017;77:728-34.
23. Berger C, Kopera D. KTP-Laser-Koagulation bei Xanthelasma palpebrarum: KTP laser coagulation for xanthelasma palpebrarum. J Dtsch Dermatol Ges. 2005;3:775-9.
24. Le Roux P. Modified blepharoplasty incisions: their use in xanthelasma. Br J Plast Surg. 1977;30:81-3.
25. Raulin C, Schoenermark MP, Werner S, Greve B. Xanthelasma palpebrarum: treatment with the ultrapulsed CO2 laser. Lasers Surg Med. 1999;24:122-7.
26. Al-Kady NA, Hamdino M, Abdel Kawy FA. Fractional CO2 laser versus trichloroacetic acid 50% for xanthelasma palpebrarum therapy. J Cosmet Dermatol. 2021;20:763-8.
27. Cisneros IQ. Treatment of Palpebral Xanthelasmas. [Doctoral Dissertation] University of Zaragoza;2022.