

## Comparison of Fractional CO<sub>2</sub> Laser with Intralesional Verapamil versus Fractional CO<sub>2</sub> Laser with Intralesional Triamcinolone for the Treatment of Keloid

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### ABSTRACT

**Background:** Although keloids of unknown origin can also develop, keloids are a skin disease where the skin expands past the borders of the initial incision. Intralesional triamcinolone (TAC) injections have been demonstrated to lessen related scar pain and itching, decrease scar volume and height, and improve scar pliability. One of calcium channel blockers; verapamil, causes the release of procollagenase, which speeds up the breakdown of scar tissue. As a result, the morphology of fibroblasts changes, TGF-1 apoptosis is induced, the formation of extracellular matrix (ECM) is decreased, and actin filaments are depolymerized.

**Objective:** comparing the efficacy and safety of fractional CO<sub>2</sub> combined with intralesional verapamil versus fractional CO<sub>2</sub> combined with intralesional triamcinolone in the treatment of keloid.

**Patients and methods:** Twenty patients with keloids participated in this investigation. They were chosen from the Dermatology Department's Outpatient Clinic at Mansoura University Hospital. Patients with two keloid were recruited; one keloid was treated with fractional CO<sub>2</sub> with intralesional verapamil (arm A) and the other was treated with fractional CO<sub>2</sub> with intralesional triamcinolone (arm B).

**Results:** In the fractional CO<sub>2</sub> laser with intralesional triamcinolone and verapamil groups, there was a statistically significant decrease in the height and surface area of keloid before and after treatment. The reduction of lesion height was significantly higher in fractional CO<sub>2</sub> laser with intralesional triamcinolone group in comparison with verapamil group (P = 0.003).

**Conclusion:** Combined fractional CO<sub>2</sub> laser with intralesional triamcinolone therapy showed better clinical improvement compared to combined fractional CO<sub>2</sub> laser with intralesional verapamil therapy, but with more adverse effects.

**Keywords:** Treatment of Keloid, Fractional CO<sub>2</sub> Laser, Intralesional Verapamil, Intralesional Triamcinolone

### INTRODUCTION

A benign fibroproliferative condition called a keloid is characterized by aberrant collagen deposition within a wound. This cutaneous "tumor" spreads past the edge of the initial lesion, grows over time, frequently returns after excision, and infrequently regresses on its own<sup>(1)</sup>.

It is believed that increased collagen and ECM synthesis and decreased breakdown lead to the development of keloid lesions. The overexpression of inflammatory mediators, specifically TGF-β1, is thought to be responsible for the increased synthesis of ECM collagen<sup>(2)</sup>.

Although there are many ways to treat keloids, none of them has been shown to be particularly successful<sup>(3)</sup>. The use of a fractional carbon dioxide laser has been the subject of more recent research<sup>(4)</sup>.

Both keloids and hypertrophic scars were treated in an early trial using CO<sub>2</sub> laser monotherapy (four treatments, six weeks apart). The findings were conflicting. Although a statistically significant decline in Vancouver-Scar-Scale (VSS) scores was observed (primarily due to greater pliability), many patients did not find this therapy to be effective<sup>(5)</sup>. In a case study, treatment with fractionated CO<sub>2</sub> laser and laser-assisted medication administration of topical triamcinolone resulted in scar shrinking and improved vision<sup>(6)</sup>.

It has been demonstrated that intralesional triamcinolone (TAC) injections can lessen related scar pain and itching while also reducing scar volume and height<sup>(7)</sup>, as well as various rate of recurrency<sup>(8)</sup>.

Verapamil, a calcium channel blocker, stimulates the release of procollagenase, which speeds up the breakdown of scar tissue. This modifies the morphology of fibroblasts, triggers TGF-β1 apoptosis, lowers the formation of ECM, and depolymerizes actin filaments<sup>(9)</sup>. Verapamil administered intralesionally for the treatment of keloid scars is risk-free<sup>(10)</sup>.

In order to treat keloid lesions, this study compares the effectiveness and safety of fractional CO<sub>2</sub> combined with intralesional verapamil with fractional CO<sub>2</sub> combined with intralesional triamcinolone.

### PATIENTS AND METHODS

Twenty patients with keloids were included in this comparative interventional investigation. They were chosen from the Mansoura University Hospitals' Dermatology, Urology, and STD Outpatient Clinic.

All studied patients had two keloid, one keloid was treated with fractional CO<sub>2</sub> with intralesional verapamil (arm A) and other was treated with fractional CO<sub>2</sub> with intralesional triamcinolone (arm B).

#### **Ethical consent:**

The Mansoura Faculty of Medicine's Institutional Review Board (IRB) accepted this research (MS.19.06.677). An informed consent was taken from every participant before inclusion of patients into the study. Every care was taken to protect the data's privacy. All data were used exclusively for scientific purposes. The Declaration of Helsinki, the World Medical Association's code of ethics for studies involving humans, guided the conduct of this research.

#### **Inclusion criteria:**

- Patients age: from 18 to 50 years
- Sex: male and female
- Duration of lesion: more than 6 month and less than 5 years
- Patients with two keloids.

#### **Exclusion criteria:**

- Pregnancy or lactating females.
- Patients who receives previous treatment for keloid in the past 12 months.
- Patients with chronic disease affecting wound healing (cardiovascular disease, diabetes, liver cell failure, malignancy and kidney disease).
- keloid results from burn.

#### **Each patient was introduced to:**

- Through history taking (personal, past, present, family history).
- Detailed general and dermatological examination.
- In patients, who were recruited as they had at least two keloids, lesion were divided in two arms of intervention according to their therapy plan:

**Arm A:** keloids were treated by fractional CO<sub>2</sub> with intralesional verapamil.

**Arm B:** keloids were treated by fractional CO<sub>2</sub> with intralesional triamcinolone.

#### **Technique:**

**Arm A:** lesion received combined treatment of fractional CO<sub>2</sub> laser with intralesional verapamil after 10 to 15 minutes at the same session for 4 successive sessions at monthly intervals. A maximum 2 mL of verapamil (2.5 mg/mL) was injected per session.

**Arm B:** Lesion received combined treatment of fractional CO<sub>2</sub> laser with intralesional triamcinolone after 10 to 15 minutes of laser session, for 4 successive session at monthly intervals. A maximum of 2 mL of triamcinolone (20 mg/mL) per session.

#### **Laser apparatus and parameters:**

Utilizing the following settings: Smart stack (10–15W), stack 3, (400–600 µm) dwelling duration, and (400–600 µm) spacing (DEKA, fractional CO<sub>2</sub> laser Smart-xide DOT, Italy). Before, after, and in between fractional CO<sub>2</sub> laser sessions, all patients got comprehensive instructions.

**Before laser session:** Before the laser treatment, a topical anesthetic cream (lidocaine 25 percent and prilocaine 25 percent pridoocaine \*R) was put under occlusion for 60 minutes..

**Post laser session:** Topical antibiotic, topical wound healing measures, emollients and sun screen in sun exposed areas.

#### **Follow up:**

##### ***Assessment of the efficacy of therapeutic procedure:***

Photographs were obtained at baseline, standardized photographs were performed using the same digital camera set at a fixed distance from the patient's lesion without flash light of the camera and were taken before every session.

Vancouver-Scar-Scale (VSS) before each session was assessed. In the case of VSS, keloid height was measured using a digital caliper, pliability was determined by palpation, vascularity was determined by ocular inspection, and pigmentation was determined by blanching the area and comparing it to the surrounding skin. (11). Before and after the final session, the total surface area of the keloid was measured using a caliper.

At the conclusion of sessions, patients were scored on a scale of 0 (not satisfied), 1 (somewhat satisfied), 2 (satisfied), 3 (very satisfied), and 4 (extremely satisfied).

#### ***Statistical analysis***

The Statistical Package for the Social Sciences (SPSS) application for Windows was used to analyse the data (Standard version 21).

The Kolmogorov-Smirnov test was initially used to determine whether the data were normal or not. Number and percentage were used to describe qualitative data.

Using the Chi-square test, associations between categorical variables were investigated. Quantitative variables were all non-parametric and were displayed as median (min-max) and were compared using the Mann Whitney test. Wilcoxon signed rank test was employed to compare the two matched groups. The level of significance for each of the aforementioned statistical tests was set at 5%. (p-value).

## RESULTS

The demographic data of the patients are shown in table 1.

**Table (1):** Demographic characteristics of the studied patients

		All patients (n= 20)
Age (years)	Median (min-max)	22.00 (18, 46)
Gender	Male	6 (30.0%)
	Female	14 (70.0%)
Socioeconomic class	Low	4 (20.0%)
	Middle	11 (55.0%)
	High	5 (25.0%)
Family history		6 (30.0%)
Data is expressed as median and range or as percentage and frequency.		

The median duration of keloid lesion was 12 months. The median length of keloid lesion was 2.70 cm. Patients had at least two lesions. The shape of lesion was mostly linear (Table 2).

**Table (2):** Lesions characteristics in the studied patients

All patients (n= 20)		Median (min-max)	Percentage and frequency
Duration of lesion (month)		12.00 (6.00, 25.00)	
Length of lesion (cm)		2.70 (2.10, 4.60)	
Number of lesions	Multiple		11 (55.0%)
	Two		9 (45.0%)
Shape	Linear		10 (50.0%)
	Oval		7 (35.0%)
	Characteristic		3 (15.0%)

Regarding Fitzpatrick skin type, type IV was the most frequent. The most frequent cause of keloids was surgery (Table 3).

**Table (3):** Skin type and causes of keloid in the studied patients

Skin type	All patients (n= 20)
III	7 (35.0%)
IV	10 (50.0%)
V	3 (15.0%)
Type of keloid	
Infection	5 (25.0%)
Surgery	9 (45.0%)
Trauma	6 (30.0%)

At each subsequent assessment, both groups showed a significant decline in vascularity, pliability, thickness, and pigmentation, which persisted through the final evaluation. Scar thickness decreased more quickly in the group using fractional CO<sub>2</sub> laser and intralesional triamcinolone; however, the difference between the two groups' rates of thickness reduction was not statistically significant. In both groups, the baseline VSS of the treated areas was considerably higher than that at each subsequent measurements and there was a significantly higher reduction of baseline VSS in fractional CO<sub>2</sub> laser with intralesional triamcinolone group compared to fractional CO<sub>2</sub> laser with intralesional verapamil group at every successive visit (2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>) (Table 4).

**Table (4):** Comparison of total Vancouver score in studied groups in different visits

		Verapamil group (n= 20)	Steroid group (n= 20)	P
		Median (min-max)	Median (min-max)	
Vascularity	Baseline	1.0 (0.0, 3.0)	1.5 (0.0, 3.0)	0.493
	First visit	1.0 (0.0, 3.0)	1.0 (0.0, 3.0) *	0.405
	Second visit	1.0 (0.0, 2.0) *	0.0 (0.0, 2.0) *	0.067
	Third visit	0.0 (0.0, 2.0) *	0.0 (0.0, 1.0) *	<b>0.028</b>
	Forth visit	0.0 (0.0, 2.0) *	0.0 (0.0, 1.0) *	<b>0.009</b>
Pigmentation	Baseline	2.0 (1.0, 2.0)	2.0 (1.0, 2.0)	1.000
	First visit	2.0 (1.0, 2.0)	2.0 (0.0, 2.0)	0.316
	Second visit	2.0 (0.0, 2.0) *	0.0 (0.0, 2.0) *	<b>0.007</b>
	Third visit	0.0 (0.0, 2.0) *	0.0 (0.0, 2.0) *	<b>0.037</b>
	Forth visit	0.0 (0.0, 2.0) *	0.0 (0.0, 2.0) *	<b>0.041</b>
Pliability	Baseline	3.0 (1.0, 5.0)	3.0 (1.0, 5.0)	0.754
	First visit	2.0 (0.0, 3.0) *	1.0 (0.0, 3.0) *	0.180
	Second visit	1.0 (0.0, 2.0) *	0.0 (0.0, 1.0) *	<b>0.001</b>
	Third visit	0.0 (0.0, 2.0) *	0.0 (0.0, 1.0) *	<b>0.004</b>
	Forth visit	0.0 (0.0, 2.0) *	0.0 (0.0, 1.0) *	<b>0.077</b>
Thickness (mm)	Baseline	1.0 (0.0, 3.0)	1.0 (0.0, 3.0)	0.757
	First visit	1.0 (0.0, 3.0) *	0.0 (0.0, 2.0) *	0.240
	Second visit	0.0 (0.0, 2.0) *	0.0 (0.0, 2.0) *	0.289
	Third visit	0.0 (0.0, 2.0) *	0.0 (0.0, 1.0) *	0.287
	Forth visit	0.0 (0.0, 2.0) *	0.0 (0.0, 0.0) *	0.076
Vancouver score	Baseline	6.0 (3.0, 12.0)	7.0 (3.0, 13.0)	0.443
	First visit	6.0 (2.0, 10.0) *	5.0 (0.0, 9.0) *	0.103
	Second visit	4.0 (0.0, 8.0) *	1.0 (0.0, 7.0) *	<b>0.001</b>
	Third visit	2.0 (0.0, 8.0) *	0.0 (0.0, 4.0) *	<b>0.002</b>
	Forth visit	2.0 (0.0, 8.0) *	0.0 (0.0, 3.0) *	<b>0.003</b>

\* indicates a significant statistical difference between each reading compared to the respective basal value

There was a significant reduction in both height and surface area of keloid before and after treatment in both fractional CO<sub>2</sub> laser with intralesional verapamil and fractional CO<sub>2</sub> laser with intralesional triamcinolone groups. In comparison to the verapamil group, the fractional CO<sub>2</sub> laser group with intralesional triamcinolone had a considerably greater reduction in lesion height (Table 5).

**Table (5):** Comparison of scar height (mm) and surface area before and after treatment

		Verapamil group (n= 20)	Steroid group (n= 20)	P
Height (mm)	Before	2.3 (0.8, 3.9)	2.2 (1.0, 8.8)	0.882
	After	1.9 (0.6, 3.2) *	0.8 (0.3, 3.4) *	<b>0.003</b>
Surface area (mm <sup>2</sup> )	Before	160.6 (38.9, 934.3)	181.2 (33.6, 806.0)	0.330
	After	133.3 (37.3, 778.0) *	126.2 (28.0, 315.2) *	0.850
* indicates a significant statistical difference between each reading compared to the basal value				

Fractional CO<sub>2</sub> laser with intralesional verapamil group showed a significant statistical higher occurrence of pain at injection site compared to fractional CO<sub>2</sub> laser with intralesional triamcinolone group.

Regarding patient satisfaction following treatment, there was no statistically significant difference between the fractional CO<sub>2</sub> laser group treated with intralesional verapamil and the fractional CO<sub>2</sub> laser group treated with intralesional triamcinolone (Table 6).

**Table (6):** Side effects at injection site and patient satisfaction after treatment in the studied groups

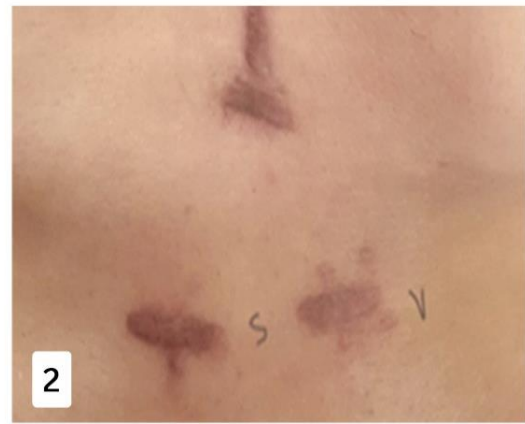
		Verapamil group (n= 20)	Steroid group (n= 20)	P
Pain at injection site	Present	12 (60.0%)	2 (10.0%)	<b>0.001</b>
	Absent	8 (40%)	18 (90%)	
Post-injection telangiectasia	Present	0 (0.0%)	4 (20.0%)	<b>0.034</b>
	Absent	20 (100.0%)	16 (80%)	
Skin atrophy	Present	0 (0.0%)	3 (15.0%)	0.072
	Absent	20 (100.0%)	17 (85%)	
<b>Patient satisfaction</b>				
Not satisfied and somewhat satisfied (Fair and Poor)		9 (45.0%)	5 (25.0%)	0.185
Satisfied, very satisfied and extremely satisfied (Good and Excellent)		11 (55.0%)	15 (75.0%)	

**CASE PRESENTATIONS**

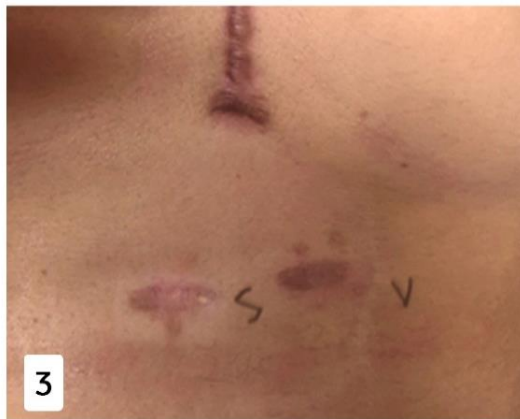
**CASE 1**



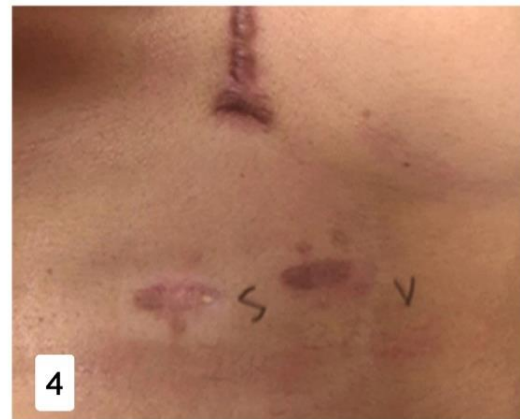
**Before Treatment**



**After First Session  
( After - 4 - Weeks)**



**After Second Session  
( After - 8 - Weeks)**



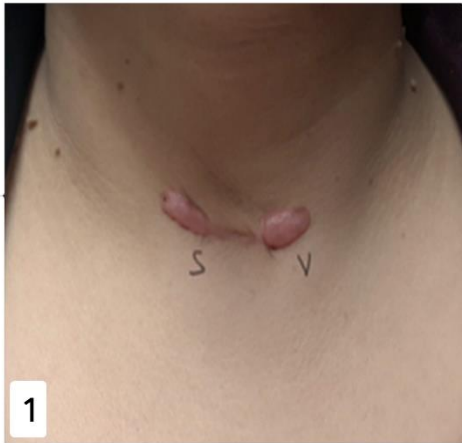
**After Third Session  
( After - 12 - Weeks)**



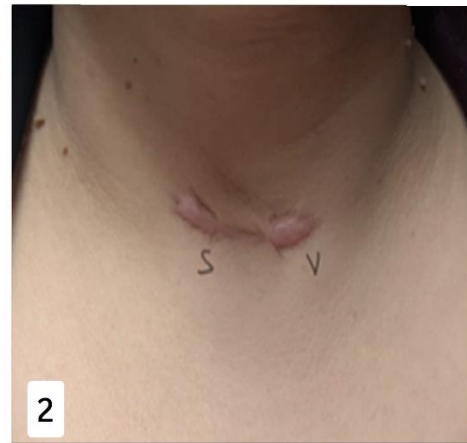
**After Forth Session  
( After - 16 - Weeks)**

**Left side (V) = fractional CO<sub>2</sub> laser with intralesional verapamil  
Right side (S) = fractional CO<sub>2</sub> laser with intralesional triamcinolone**

**CASE 2**



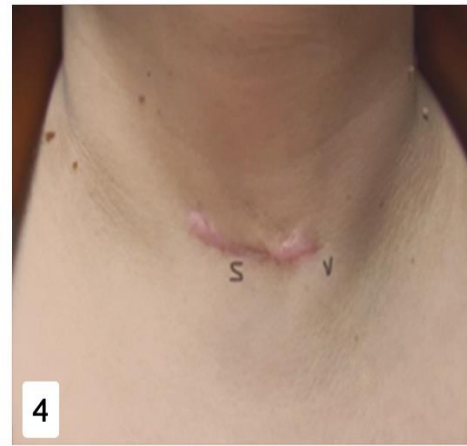
**Before Treatment**



**After First Session  
( After - 4 - Weeks)**



**After Second Session  
( After - 8 - Weeks)**



**After Third Session  
( After - 12 - Weeks)**



**After Forth Session  
( After - 16 - Weeks)**

**Left side (V) = fractional CO<sub>2</sub> laser with intralesional verapamil  
Right side (S) = fractional CO<sub>2</sub> laser with intralesional triamcinolone**

## DISCUSSION

In the present study, the median age of patients was 22 (min-max=18 - 46) years as this is the age of increase activity and more exposure to trauma. Furthermore, the second to third decade saw the highest prevalence of keloid<sup>(1)</sup>.

This study included 6 males (30%) and 14 females (70%). The male to female ratio in cohorts of keloids patients is about 1:2, according to a number of earlier research<sup>(12-15)</sup>. However, it is generally accepted that both men and women are equally likely to develop keloids, and that patients with keloids who visit the hospital for treatment are more likely to be women due to social factors, such as the fact that women care more about their appearance than men do, are less resistant to medical testing, and are more likely to have their ears pierced<sup>(16)</sup>. **Noishiki et al.**<sup>(17)</sup> indeed suggests that the female gender possesses a systemic component that is innate and substantially encourages the formation or spread of keloid.

In the current study, family history was present only in 30 % of our patients. This was in accordance with **Aggarwal et al.**<sup>(18)</sup>, **Damanik et al.**<sup>(19)</sup> and **Khattab and Samir**<sup>(20)</sup>, they found that family history was positive in 17.5%, 37.5% and 43.75 of keloid patients respectively.

In the present study, the shape of keloid was linear, oval and irregular in 10, 7, 3 patients respectively. According to descriptions, keloids can be classified as "regular" with a circular shape and distinct curving lines or "irregular" with asymmetrical shapes and lines<sup>(21)</sup>. Furthermore **Bayat et al.**<sup>(22)</sup> illustrated keloid as (1) geometric (globular, spheroidal, linear, as well as ovoid), (2) recognizable (reniform, petaloid, dumbbell, butterfly, as well as propeller botryoid) and (3) irregular (unrecognizable outlines, nongeometrical).

Regarding Fitzpatrick skin type, we recorded type III, IV, V skin type in 35%, 50%, 15% of patients respectively. This was near similar to another Egyptian study conducted by **Soliman et al.**<sup>(23)</sup> who reported that the most common Fitzpatrick Skin type was type IV in 48.9% of the patients with keloid followed by type III in 46.7% of the patients, while type II was the least common in 4.4% of the patients. The Fitzpatrick skin type has a significant impact on the epidemiology of keloids, with incidences ranging from 4.5 percent to 16 percent in type VI to just 0.09 percent in type I<sup>(24)</sup>.

At each subsequent evaluation in the current study, there was a substantial decrease in both groups' vascularity, pliability, thickness, and pigmentation, and this decrease persisted through the final assessment. The fractional CO<sub>2</sub> laser group receiving intralesional triamcinolone showed a faster rate of healing in scar thickness, although this difference in rate of improvement was not statistically significant.

In this study, baseline VSS of treated areas in both groups was noticeably higher than that at each

subsequent assessment. Furthermore, there were significantly reduction of baseline VSS in fractional CO<sub>2</sub> laser with intralesional triamcinolone group compared to fractional CO<sub>2</sub> laser with intralesional verapamil group at every successive visits.

In our study, there was a significant reductions in both height and surface area of keloid before and after treatment in both fractional CO<sub>2</sub> laser with intralesional verapamil and fractional CO<sub>2</sub> laser with intralesional triamcinolone groups. The reduction of lesion height was significantly higher in fractional CO<sub>2</sub> laser with intralesional triamcinolone group in comparison with verapamil group.

There are currently many keloid treatment options available, but none of them has yet been shown to be particularly successful<sup>(25)</sup>. Interferons, retinoids, botulinum toxin-A, imiquimod 5 percent cream cryotherapy, silicone sheeting, laser therapy, surgical excision, laser therapy intralesional injections of corticosteroids, radiation therapy, compression therapy, 5-fluorouracil, and bleomycin are a few of the modalities that have been tried either alone or in various combinations with varying degrees of success. There are, however, very few attempts to compare their effectiveness and safety<sup>(18)</sup>.

There are few published studies on the topic of treating keloids with a fractionated CO<sub>2</sub> laser and topical triamcinolone acetone (TAC). In contrast to the often used intralesional corticosteroids, fractionated CO<sub>2</sub> laser enables penetration of topical medications into the dermis after production of a micro-turbine generation simulation system and improves drug delivery to target tissue. **Kraeva et al.**<sup>(6)</sup>, **Martin and Collawn**<sup>(26)</sup>, and **Waibel et al.**<sup>(27)</sup> revealed that an African-American man named Fitzgerald VI underwent a reported successful treatment of keloid using a combination therapy of topical TAC ointment and fractionated CO<sub>2</sub> laser, with great cosmetic improvements that lasted 22 months after the procedure. They believed that this combination therapy approach could help individuals with keloids who had skin of color (Fitzpatrick IV–VI) as well as other patients. Following fractionated CO<sub>2</sub> laser treatment, topical TAC ointment use may be an effective, non-invasive substitute for intralesional steroids.

**Srivastava et al.**<sup>(28)</sup> examined the three regimens of CO<sub>2</sub> laser, triamcinolone, and verapamil for the treatment of keloid growths. At each assessment, all three groups showed a decrease in height, vascularity, pliability, and pigmentation, which persisted until the final evaluation. The measure that remained unaffected by any of the treatment groups was scar pigmentation. Triamcinolone showed a higher rate of improvement in scarring, but there was no statistically significant difference between the three medicines' rates of pigmentation decrease. Each of these therapy modalities had a distinct benefit, and the



course of action must be tailored to the specifics of the scar. In contrast to triamcinolone, time is a constraint with laser and verapamil, but they have no negative side effects. Fractional laser therapy should be used on scars. Triamcinolone can be substituted with verapamil, which is more affordable <sup>(29)</sup>.

A common calcium channel antagonist, verapamil hydrochloride increases collagenase while decreasing the production of extracellular matrix components such as collagen, glycosaminoglycans, and fibronectin. Early non-randomized clinical trials using intralesional verapamil either alone or as an adjuvant after surgery have demonstrated positive outcomes <sup>(30)</sup>.

**Ahuja and Chatterjee** <sup>(29)</sup> compared intralesional injections of triamcinolone (40 mg/mL) and/or verapamil (2.5 mg/mL) in a blinded clinical experiment. Up to eight sessions were needed to completely flatten the scar, with injections administered every three weeks. The VSS score was used to assess the scar's pliability, vascularity, height, and color. Regarding scar height, vascularity, and pliability, mean zero VSS scores were attained with both treatments, but the TAC response was quicker and more efficient.

Due to the pharmacological actions of triamcinolone, which reduce proteinase inhibitors, and verapamil, which increase procollagenase secretion, the combination of the two medicines results in an increase in collagenase levels and collagen disintegration within the scar. <sup>(31)</sup>.

As far as we are aware, this is the first study to examine the effectiveness of utilizing a combination of fractional CO<sub>2</sub> laser and intralesional triamcinolone vs a combination of both fractional CO<sub>2</sub> laser and intralesional verapamil in the treatment of keloids..

In the present study, regarding adverse effects, fractional CO<sub>2</sub> with intralesional verapamil group showed only pain at injection site (60%), While fractional CO<sub>2</sub> laser with intralesional triamcinolone group showed pain at injection site (10%), post-injection telangiectasia (20%) and skin atrophy (15%). Fractional CO<sub>2</sub> laser with intralesional verapamil group showed a significant statistical higher occurrence of pain at injection site compared to fractional CO<sub>2</sub> laser with intralesional triamcinolone group.

In agreement with our result, in **Ahuja and Chatterjee** <sup>(29)</sup> study, the complication rate was greater in the TAC group (skin atrophy and telangiectasias). On the contrary, verapamil was shown to have no side effects, with the exception of the injection-related pain that required analgesia.

Similarly, in **Srivastava et al.** <sup>(28)</sup> study, after two to three treatment sessions, all three groups had a reduction in discomfort and itch. The majority of patients find telangiectasia, skin shrinkage, and changed pigmentation to be the most common side effects associated with TAC.

Regarding patient satisfaction following treatment, there was no statistically significant difference between the fractional CO<sub>2</sub> laser group receiving intralesional verapamil and the fractional CO<sub>2</sub> laser group receiving intralesional triamcinolone.

## CONCLUSION

This study revealed that combined fractional CO<sub>2</sub> laser with intralesional triamcinolone therapy showed better clinical improvement compared to combined fractional CO<sub>2</sub> laser with intralesional verapamil therapy, but with more adverse effects.

We postulated that fractional CO<sub>2</sub> laser could increase the depth of penetration of drug applied hence augmenting its effect.

## RECOMMENDATIONS

- As it has been demonstrated in numerous research that CO<sub>2</sub> laser is more effective if utilized early, additional large-scale studies with bigger sample sizes are needed to describe the scar's response.
- Larger follow up period is required to assess the maintained response or recurrence.
- Strong recommendations for keloid therapy using fractionated CO<sub>2</sub> laser with TAC injection in patients with skin of color require more randomized controlled trials and split-scar studies to fine-tune fractionated CO<sub>2</sub> laser settings and treatment protocols.
- Further study using different concentration of triamcinolone combined with CO<sub>2</sub> laser to grade against adverse effect as atrophy and telangiectasia.
- It is advised to select a good combination therapy and hold more sessions with more patients in order to achieve better results and greater patient satisfaction.

**Conflict of interest:** The authors declare no conflict of interest.

**Sources of funding:** This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

**Author contribution:** Authors contributed equally in the study.

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