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Original Article

Dermatology Section

Comparison of the Efficacy of Intralesional Triamcinolone Acetonide Alone versus Triamcinolone Acetonide Combined with Hyaluronidase in the Treatment of Keloids: A Prospective Interventional Study

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ABSTRACT

Introduction: The management of keloids remains a significant therapeutic challenge due to their chronic nature, resistance to treatment, and tendency to recur. Various modalities of management include surgery, laser therapy, cryotherapy, silicone sheets, radiation and intralesional injections. First-line therapy is intralesional Triamcinolone Acetonide (TAC), but it often causes dermal atrophy and hypopigmentation. Combination therapies are increasingly explored to enhance the efficacy, reduce the adverse effects, and minimise recurrence.

Aim: To compare the efficacy of intralesional injection of triamcinolone alone vs intralesional injection of triamcinolone combined with hyaluronidase in the treatment of keloids.

Materials and Methods: The present open-label prospective interventional study conducted at the Dermatology Outpatient Department (OPD) of Government Rajaji Hospital, Madurai, Tamil Nadu, India, from June 2023 to August 2024, involving 36 patients with keloids. Patients were randomly assigned to two groups (n=18 each): Group 1 received intralesional TAC alone; Group 2 received TAC plus hyaluronidase. Intralesional injections were administered every three weeks for up to maximum of six sessions. Efficacy was evaluated by assessing the vascularity, pigmentation, pliability, height, pain/itching by modified Vancouver Scar Scale (mVSS). Data were entered in Microsoft Excel and analysed using Statistical Package for the Social Sciences (SPSS) software. Chi-square test was applied, with $p<0.05$ considered statistically significant. Clinical photographs were taken at baseline and before each injection session.

Results: The mean age of the study population was 31.64 year (range 20-50 years). Among the participants, 26 (72.22%) were male and 10 (27.78%) were female, giving a male-to-female ratio of approximately 2.6:1. The onset of the lesion was spontaneous in 16 cases, preceded by trauma 10 cases and surgery six cases. Analysis of substance use revealed that 4 (11.11%) were alcoholic, 4 (11.11%) were smokers and 2 (5.56%) were both alcoholic and smoker. The mean VSS score decreased from 13.66 at baseline to 2.7 at 18 weeks in Group 2, compared with 13.5 to 4.1 in Group 1. Group 2 demonstrated significantly greater improvement in VSS scores from week six through week 15 (significant p-value for Group 2-$p<0.05$). Complete resolution of keloid was achieved in 16 of 18 patients (88.9%) in Group 2 versus 12 of 18 patients (66.7%) in Group 1 at 18 weeks with the remaining patients in each group achieving partial resolution.

Conclusion: Combination TAC with hyaluronidase yielded superior efficacy (89% complete resolution) over TAC alone (67%). Though both treatments were efficacious, combination therapy is recommended for faster results, lower relapse and minimal side-effects.

Keywords: Combination therapy, Efficacy, Monotherapy, Resolution, Vancouver scar scale

INTRODUCTION

A keloid is an abnormal type of scar that forms due to an overactive wound healing response, where excess collagen and connective tissue are deposited in the dermis. Unlike normal scars, keloids grow beyond the boundaries of the original injury and do not regress over time [1]. Globally, they are seen in 5-15% of all wounds [2]. In South India, keloids are frequently seen among individuals with Fitzpatrick skin types IV to VI [3]. A combination of genetic, environmental, and physiological factors causes keloids. The primary trigger is skin trauma, which may result from surgical wounds, burns, acne, vaccinations, or even trivial trauma [4]. Keloids present clinically as firm, raised, and often shiny scars and typically appear weeks to months after skin injury growing slowly over time. Keloids vary in colour, often appearing pink, red, or dark brown depending on the individual's skin tone. They are commonly found on the chest, shoulders, upper back, earlobes, and cheeks- areas prone to skin tension. Patients often report itching, tenderness, or pain, especially in active or newly formed keloids [5].

Although keloids are non-cancerous, they can cause significant physical and emotional discomfort. Common symptoms include persistent itching, pain, burning sensations, and tenderness. Large keloids can restrict movement near joints or mobile areas such as the neck or shoulders. Beyond the physical symptoms, keloids can be a source of psychological distress due to their unsightly appearance, particularly when they occur on visible areas like the face or chest [6]. Treatment of keloids remains challenging owing to their high propensity to recur, particularly after surgical excision, often requiring prolonged multimodal management [7]. The first-line treatment is intralesional corticosteroid injections, particularly TAC, which reduces inflammation and collagen production. It is a commonly used treatment and is often administered at concentrations ranging from 10 to 40 mg/mL, usually repeated every three to four weeks for several sessions, depending on the response [8,9]. The treatment is generally well-tolerated, though local side-effects such as local skin atrophy, hypopigmentation, and telangiectasia may occur, especially with prolonged use or high concentrations. Despite these limitations,

it remains a valuable tool in treating keloids. Other options include topical silicone gel sheets, pressure therapy, cryotherapy, and laser therapy, which aim to flatten and soften the scar tissue [10].

More resistant cases may benefit from intralesional chemotherapeutic agents such as 5-fluorouracil or bleomycin. Surgical excision is often considered, but it must be followed by adjunctive therapy such as corticosteroid injection or radiotherapy to minimise recurrence. Recently, combination therapies have gained attention for offering better outcomes than monotherapies [11]. Hyaluronidase is an enzyme that breaks down hyaluronic acid, a significant component of the extracellular matrix in the skin and connective tissues. Hyaluronidase is used to facilitate the dispersion and absorption of other injected drugs, including corticosteroids like triamcinolone in the treatment of keloids. Hyaluronidase can modify the fibrotic extracellular environment, allowing corticosteroids to penetrate more effectively and act on the target tissue [12]. However, it may require more expertise to prepare and administer, and the cost is slightly higher.

Previous research has evaluated the efficacy of three distinct interventions: a combination of hyaluronidase with TAC 40 mg/mL (yielding an effective TAC concentration of 20 mg/mL in the mixture), TAC 40mg/mL, intralesional radiofrequency with TAC 40mg/mL [13]. In contrast, the present study standardised the corticosteroid dosage across both intervention arms to an identical concentration of 20mg/mL. Group 1 received TAC diluted with normal saline as monotherapy, while Group 2 received a combination of TAC and hyaluronidase. This standardisation allowed for a targeted assessment of treatment response and side-effect profiles, specifically isolating the additive effect of hyaluronidase. With this background in mind, the present study was done to compare the efficacy of intralesional injection of triamcinolone alone vs triamcinolone combination with hyaluronidase in the treatment of keloids.

MATERIALS AND METHODS

The present open-label prospective interventional study was conducted in the Dermatology Outpatient Department (OPD), Government Rajaji Hospital, Madurai, Tamil Nadu, India, over a 14-month period from June 2023 to August 2024 after ethical committee approval. (CDSCO: Reg.No: ECR/1365/Inst/TN/2020 & DHR Reg.No: EC/NEW/INST/2022/TN/0059) Thirty-six patients aged 18-60 years with clinically diagnosed keloids were enrolled after screening.

Sample size calculation: Sample size calculated based on a similar study using the formula:

$$N=\frac{2\sigma^2(Z_{1-\alpha}+Z_{1-\beta})}{(d+\delta)^2}$$

$\sigma 2$ - 11.79

Z1 - α - 1.96

Z1 - β - 0.84

d - 1.64

δ - 1.5

N=18

Sample size was calculated as 18 for each group [13].

Inclusion criteria: Patients of both sexes with familial or acquired keloids measuring 1-10 cm in maximum dimension and of less than 15 years duration were included. In patients with multiple keloids, only the largest one (≤10 cm) was selected for treatment. All patients provided written informed consent and were willing to attend regular follow-up visits.

Exclusion criteria: Exclusion criteria were based pregnancy or lactation, active local or systemic infection/inflammation, immunosuppressive therapy, significant comorbid medical conditions, known hypersensitivity to TAC and hyaluronidase or bee/wasp venom, HIV seropositivity, prior keloid treatment within six months, and keloids in ear or periorbital areas.

Study Procedure

Baseline demographic data, including age, gender, co-morbidities, smoking and alcohol use were obtained via patient interview, questionnaire, and electronic medical record review at the time of enrolment.

Patients were randomly allocated using simple random sampling in an alternating sequence into two equal groups (n=18 each). Group 1 received intralesional TAC alone, and Group 2 received intralesional TAC combined with hyaluronidase. Injections were administered every three weeks for a maximum of six sessions or complete resolution whichever is earlier.

Clinical photographs were taken under standardised lighting and positioning at baseline and before each injection session. Serial photographic documentation and clinical assessments were maintained throughout treatment and follow-up. Efficacy was objectively measured using the mVSS at each visit [14-16].

Group 1 {Triamcinolone Acetonide (TAC) monotherapy}: The keloid was cleansed with surgical spirit and allowed to air-dry. A 1 mL of TAC 40 mg/mL was withdrawn and diluted with 1 mL of sterile water for injection, yielding a final concentration of 20 mg/mL. Using a 30-gauge insulin syringe, 0.1 mL (2 mg of TAC) was injected intralesionally via multi-puncture technique at multiple points spaced 1 cm apart and at a depth of 3-7 mm until visible blanching of the entire lesion occurred without extending into the surrounding normal skin.

Group 2 {Triamcinolone Acetonide (TAC) + hyaluronidase combination}: Hyaluronidase powder was reconstituted with 1 mL of sterile water for injection to obtain a concentration of 1500 IU/mL. This solution was immediately mixed in a 1:1 ratio with undiluted TAC 40 mg/mL, resulting in a final concentration of TAC 20 mg/mL and hyaluronidase 750 IU/mL. After confirming the absence of hypersensitivity with a test dose (0.1 mL administered intradermally on the forearm, 0.1 mL of the mixture (containing 2 mg TAC and 75 IU hyaluronidase) was injected intralesionally using the same technique as in Group 1.

In both groups, injections were administered at 3-week intervals for a maximum of six sessions or until complete flattening of the keloid was achieved, whichever occurred earlier. The maximum dose of TAC per session did not exceed 40 mg per session in either group.

Clinical assessment: Clinical assessment of the scars was performed at the beginning of the present study and every three weeks after starting treatment until 18 weeks.

Response was evaluated as follows:

- Complete response - Total resolution of keloid (height of keloid 1mm or less) [13];
- Partial response - Decrease in size of the keloid, but not less than 1mm in height;
- No response - No decrease in size of the keloid at the end of 18 weeks.

The assessment of therapeutic efficacy was based on the mVSS at baseline (prior to the first treatment session), before each subsequent treatment session and three weeks after the last treatment session.

Assessment of the therapeutic efficacy was based on mVSS before each treatment session and three weeks after the last treatment session.

Modified VSS evaluates five indicators:

- Vascularity rated by visual inspection and the rate of refill, after blanching it. Blanching was achieved by a transparent plastic sheet;

- Pigmentation was assessed after blanching and comparing the scar colour with the surrounding skin;
- Pliability assessed by palpation;
- Height was measured with calipers;
- Pain/itching assessed by history.

The mVSS score ranged from 0-16. The decreasing mean value of the total score indicates clinical improvement, in the scar. The percentage reduction in VSS was graded according to the Quartile score

Percentage reduction={(Pre-score - post-score)/Pre-score} × 100

- ≤25% reduction in VSS graded as poor
- 26-50% reduction as good
- 51-75% reduction very good
- >75% reduction as excellent response

STATISTICAL ANALYSIS

Data were entered in Microsoft Excel and analysed using SPSS software; continuous variables were expressed as mean±standard deviation, categorical variables as frequencies and proportions, and treatment efficacy reported with 95% confidence intervals. Chi-square test was applied, with $p<0.05$ considered statistically significant.

RESULTS

A total of 36 patients (18 in each group) completed the study. The mean age of the study population was 31.64 years (range 20-50 years). Most participants 18 (50%) were under 30-year-old, while 10 (28%) were between 31-40 years, and 8 (22%) fell within the 41-50 years age group. Among the participants, 26 (72.22%) were male and 10 (27.78%) were female, giving a male-to-female ratio of approximately 2.6:1. Demographic data given in [Table/Fig-1].

Variables	Frequency
Age (years)	20-50 (mean- 31.64)
Sex	**N (%)**
Male	26 (72.22)
Female	10 (27.7)
Co-morbidities	
Hypertension (HT)	7 (19)
Diabetes mellitus (DM)	4 (11)
Both HT and DM	3 (8)
Nil	22 (61)
Addictive behaviour	
Alcoholic	4 (11)
Smoker	4 (11)
Both alcoholic and smoker	2 (5.56)
Nil	26 (72)

[Table/Fig-1]: Demographic data.

The most commonly affected site was the pre sternal region in 8 cases (22.22%), followed by the back in 7 (19.44%), and shoulder in 7 (19.44%). Other affected areas included the forearm in 6 (16.67%), knee in 4 (11.11%), and miscellaneous sites in 4 (11.11%). Group wise distribution showed variability, with the pre sternal region being more common in Group 1 in 5 (27.78%) compared to Group 2 in 3 cases (16.67%). The distribution of keloid sites in Group 1 (n=18) was as follows: pre-sternal region 5 (27.78%), shoulder 4 (22.22%), back 3 (16.67%), forearm 3 (16.67%), knee 2 (11.11%), and others 1 (5.56%). In Group 2 (n=18), the distribution was: back 4 (22.22%), pre sternal region 3 (16.67%), forearm 3 (16.67%), shoulder 3 (16.67%), others 3 (16.67%), and knee 2 (11.11%) [Table/Fig-2].

The most common cause was spontaneous onset, accounting for 16 cases (44.44%). Trauma followed as the second most prevalent cause with 10 cases (27.78%), while surgical procedures contributed to six cases (16.67%). Less frequent causes included acne with 3 cases (8.33%) and herpes zoster with 1 case (2.78%). Baseline characteristics of keloid among study participants given in [Table/Fig-2].

Site	N (%)	Group 1	Group 2
Pre sternal	8 (22)	5 (27)	3 (16)
Shoulder	7 (19)	4 (22)	3 (16)
Back	7 (19)	3 (16)	4 (22)
Forearm	6 (16)	3 (16)	3 (16)
Knee	4 (11)	2 (11)	2 (11)
Others	4 (11)	1 (5)	3 (16)
Aetiology	**N (%)**		
Spontaneous	16 (44)	9 (50)	7 (38)
Trauma	10 (27)	5 (27)	5 (27)
Surgery	6 (16)	3 (16)	3 (16)
Acne	3 (8)	1 (5)	2 (11)
Herpes zoster	1 (2)	0 (0)	1 (5)
Symptoms	**N (%)**		
Pain	4 (11)	2 (11)	2 (11)
Itching	2 (5)	1 (5)	1 (5)
Irritation	1 (2)	0 (0)	1 (5)
Redness	1 (2)	1 (5)	0 (0)
Nil	28 (77)	14 (77)	14 (77)
Duration	**years**		
Mean	3.75	4.5	3
Prior treatment history	**N (%)**		
Nil	30 (83)	14 (77)	16 (88)
Present	6 (16)	4 (22)	2 (11)

[Table/Fig-2]: Baseline characteristics of keloids among study participants.

The mean keloid size before treatment was 2.39 cm, ranging from 1 cm to 4 cm. Group 1 had a slightly smaller mean size (2.22 cm) than Group 2 (2.56 cm). The mean size of keloid at the end of 18 weeks was 0.26 cm, ranging from 0.1 to 1 cm. Group 1 had a slightly larger mean final size (0.31 cm) at the End of 18 Weeks compared to Group 2 (0.2 cm), though the difference was not statistically significant (p=0.2906) [Table/Fig-3,4]. Age, gender and co-morbidities were evaluated as influencing factors. Participants under 30 years showed the highest rate of complete resolution [Table/Fig-5].

Height in cm at the beginning	Mean	Var	SD	Min.	Max.
Total	2.388	0.873	0.9344	1	4
Group 1	2.2222	0.5359	0.7321	1	3
Group 2	2.5556	1.2026	1.0966	1	4

[Table/Fig-3]: Height of Keloids in Group 1 and Group 2 at beginning stage.
SD-Standard deviation

Height in cm at the end of 18 weeks	Group 1		Group 2		p-value
	Mean	SD	Mean	SD	
	0.3111	0.3288	0.2	0.291	0.2906

[Table/Fig-4]: Group wise distribution of keloid height at the end of 18 weeks.

Age (Years)	Group 1		Group 2	
	Complete resolution	Partial Resolution	Complete resolution	Partial Resolution
<30	7	1	8	0
31-40	2	4	5	1
41-50	3	1	3	1

[Table/Fig-5]: Age distribution and resolution outcomes of groups 1 and 2.

Males demonstrated better resolution rates than females in both groups [Table/Fig-6].

Gender	Group 1		Group 2	
	Complete resolution	Partial Resolution	Complete resolution	Partial Resolution
Female	1	4	5	0
Male	11	2	11	2

[Table/Fig-6]: Gender and Resolution Outcomes of Groups 1 and 2.

Presence of co-morbidities did not affect the treatment outcome in either group [Table/Fig-7].

Co-morbidities	Group 1		Group 2	
	Complete resolution	Partial resolution	Complete resolution	Partial Resolution
Yes	5	3	5	1
No	7	3	11	1

[Table/Fig-7]: Outcome in relation with co-morbidities in Group 1 and Group 2.

The overall mean duration of keloid was 3.75 years. Group 1 had a longer mean duration (4.5 years) compared to Group 2 (3 years). The median durations were 4.5 and three years, respectively [Table/Fig-8].

Duration (in years)	Mean	Var	SD	Min	Max	Median
Group 1	4.5	8.5	2.9155	1	11	4.5
Group 2	3	2.4706	1.5718	1	7	3
Total	3.75	5.9071	2.4305	1	11	3

[Table/Fig-8]: Keloid duration distribution of groups 1 and 2.

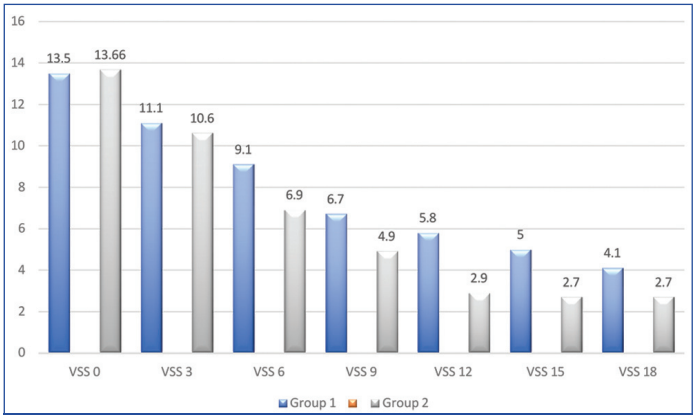
The baseline mean mVSS score was comparable between the two groups (13.58±2.1). The mean VSS score decreased from 13.66 at baseline to 2.7 at 18 weeks in Group 2, compared to 13.5 at baseline to 4.1 in Group 1 [Table/Fig-9].

	VSS 0	VSS 3	VSS 6	VSS 9	VSS 12	VSS 15	VSS 18
Group 1	13.5	11.1	9.1	6.7	5.8	5.0	4.1
Group 2	13.66	10.6	6.9	4.9	2.9	2.7	2.7
p- value	0.6717	0.3362	0.0039	0.0037	0.0066	0.0045	0.2166

[Table/Fig-9]: Resolution based on mean VSS Scores At 0, 3, 6, 9, 12, 15 and 18 weeks.
p-value <0.05 is considered significant

Progressive reduction in VSS scores was observed in both groups; however, Group 2 showed greater reduction in VSS scores over time, with statistically significant differences between groups observed at weeks 6, 9, 12, and 15 ($p<0.05$). Group 2 showed a more consistent and faster reduction in VSS scores over the study period compared to Group 1 [Table/Fig-10].

Group 2 demonstrated a stronger treatment response on average, with a mean percentage reduction in VSS scores of 80.23%, which



[Table/Fig-10]: Bar chart of resolution based on mean VSS scores at 0, 3, 6, 9, 12, 15 and 18 weeks.

falls into the excellent category according to the established quartile grading system (≤25%=poor; 26-50%=good; 51-75%=very good; >75%=excellent). In contrast, Group 1 achieved a mean percentage reduction of 69.63%, corresponding to a very good response [Table/Fig-11].

Group	Pre-score (mean)	Post-score (mean)	Reduction (absolute)	% Reduction	Response Grade
Group 1	13.5	4.1	9.4	69.63	Very good
Group 2	13.66	2.7	10.96	80.23	Excellent

[Table/Fig-11]: Percentage reduction of VSS score (mean) at 18 weeks.

Among the four main components of VSS, higher improvement in pliability noted in Group 2 from six weeks [Table/Fig-12].

Parameter/ No. of weeks	Groups	0	3	6	9	12	15	18
Vascularity	Group 1	2.38	1.94	1.52	1.11	0.83	0.44	0.11
	Group 2	2.5	1.77	1.05	0.66	0.44	0.05	0
Pigmentation	Group 1	3	2.83	2.61	2.16	1.94	1.5	0.77
	Group 2	3	2.66	2.05	1.5	1	0.72	0.33
Pliability	Group 1	4	3.88	3.05	2.83	2.33	1.66	1.16
	Group 2	4.5	3.83	2.94	2.51	1.83	1.27	0.83

[Table/Fig-12]: Observations of therapeutic responses (mean values of each parameter are depicted in the table).

Complete resolution (≥90% reduction in VSS with clinical flattening and softening) was achieved in 12 of 18 patients (66.7%) in Group 1 and 16 of 18 patients (88.9%) in Group 2. The remaining patients in each group showed partial resolution (50-89% improvement) [Table/Fig-13].

Groups	Complete resolution	Partial resolution	Efficacy
Group 1	12	6	66.7%
Group 2	16	2	88.9%

[Table/Fig-13]: Group 1 and Group 2 outcome at 18 weeks.
Chi-square value- 2.571
p-value- 0.108

Time to complete resolution was significantly shorter in Group 2 (median 9 weeks versus 15 weeks in Group 1) [Table/Fig-14].

Groups	Outcome	0 wk	3 wk	6 wk	9 wk	12 wk	15 wk	18 wk
Group 1	No resolution	18	15	7	0	0	0	0
	Partial resolution (<75%)	0	3	11	0	0	0	0
	Partial resolution (<50%)	0	0	0	18	18	13	6
	Complete resolution	0	0	0	0	0	5	12
Group 2	No resolution	18	12	1	0	0	0	0
	Partial resolution (<75%)	0	6	11	0	0	0	0
	Partial resolution (<50%)	0	0	6	13	9	6	2
	Complete resolution	0	0	0	5	9	12	16

[Table/Fig-14]: Outcome over time in Group 1 and Group 2.

Adverse effects were mild and infrequent. No side-effects were reported by 80.6% of patients. Injection-site pain and hypopigmentation each occurred in 5.6% of cases; dermal atrophy, depigmentation, and telangiectasia were seen in fewer than 3%. All adverse effects were more common in Group 1 [Table/Fig-15].

Clinical photographs demonstrating pre-treatment scar characteristics (a) and post-treatment outcomes (b) in Group 1 are shown in [Table/Fig-16-19]; analogous images for Group 2 are presented in [Table/Fig-20-23].

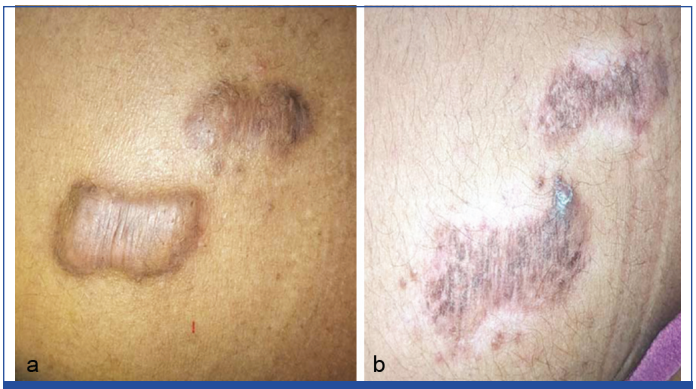
DISCUSSION

Keloids predominantly affect younger individuals due to heightened fibroblastic activity and increased collagen synthesis during the

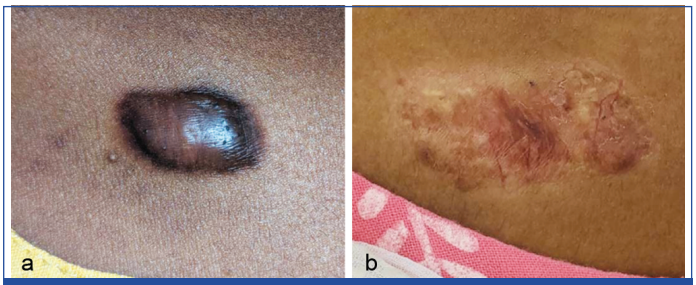
second to fourth decades of life. The age distribution in our study showed a mean age of 31.64 years and a majority of patients under

Side-effects	Frequency (%)	Group 1	Group 2
Pain	2 (5.5)	1	1
Hypopigmentation	2 (5.5)	1	1
Atrophy	1 (2.8)	1	-
Depigmentation	1 (2.8)	1	-
Telangiectasia	1 (2.8)	1	-
Nil	29 (80.5)	13	16

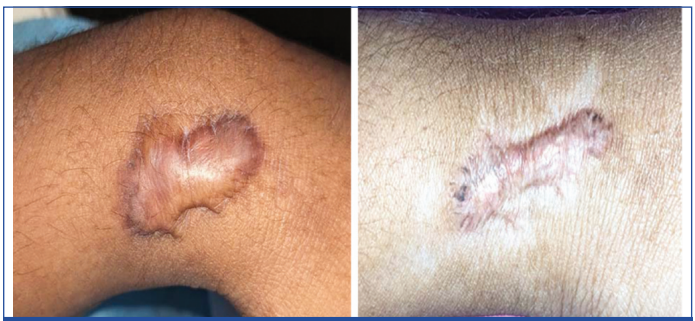
[Table/Fig-15]: Side-effects among Group 1 and Group 2.



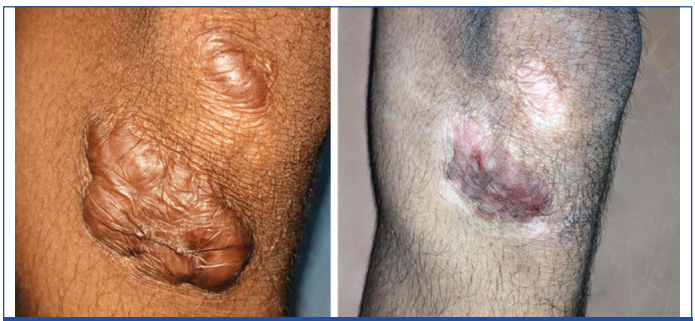
[Table/Fig-16]: Treatment of keloid over right shoulder with Intralesional Triamcinolone Acetonide (TAC) monotherapy in a 24-year-old female; a) Before treatment; b) Complete resolution at 18 weeks.



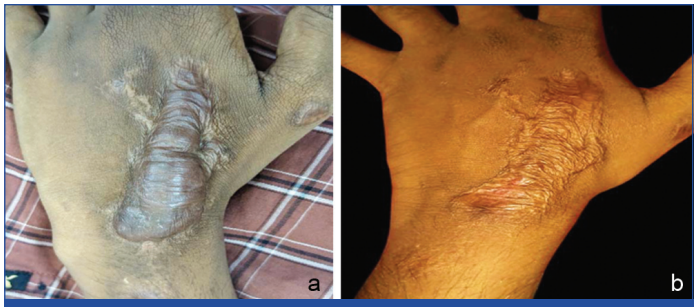
[Table/Fig-17]: Treatment of keloid at parasternal region with intralesional Triamcinolone Acetonide (TAC) monotherpy in a 20-year-old female; a) Before treatment; b) Complete resolution at 18 weeks.



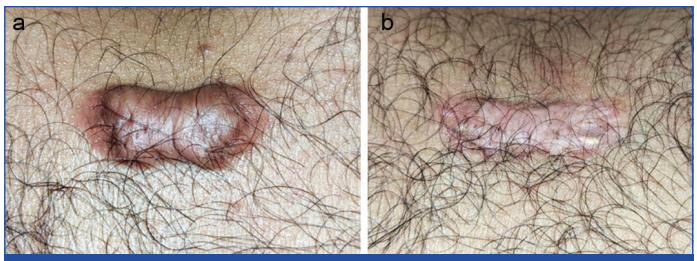
[Table/Fig-18]: Treatment of keloid at left wrist with intralesional Triamcinolone Acetonide (TAC) monotherapy in a 35-year-old female; a) Before treatment; b) Complete resolution at 18 weeks.



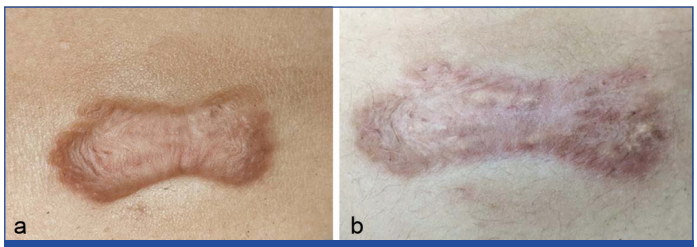
[Table/Fig-19]: Treatment of keloid at left knee with intralesional Triamcinolone Acetonide (TAC) monotherapy in a 22-year-old male; a) Before treatment; b) Complete resolution at 18 weeks.



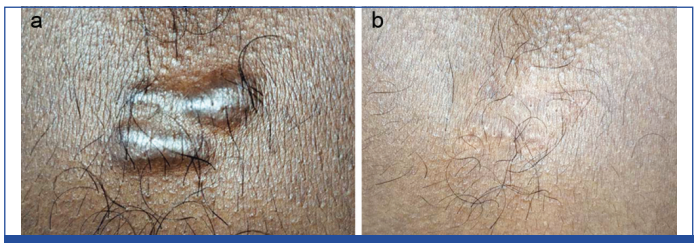
[Table/Fig-20]: Treatment of keloid over left hand with combination of intralesional Triamcinolone Acetonide (TAC) and hyaluronidase in a 21-year-old male; a) Before treatment; b) Complete resolution at 18 weeks.



[Table/Fig-21]: Treatment of keloid over presternal region with combination of intralesional Triamcinolone Acetonide (TAC) and hyaluronidase in a 28-year-old male; a) Before treatment; b) Complete resolution at 15 weeks.



[Table/Fig-22]: Treatment of keloid over presternal region with combination of intralesional Triamcinolone Acetonide (TAC) and hyaluronidase in a 22-year-old female; a) Before treatment; b) Complete resolution at 12 weeks.



[Table/Fig-23]: Treatment of keloid over presternal region with combination of intralesional Triamcinolone Acetonide (TAC) and hyaluronidase in a 20-year-old male; a) Before treatment; b) Complete resolution at 12 weeks.

30 years of age. A study by Shaheen A et al., noted peak keloid incidence in the second and third decades of life [17].

Swenson A et al., also observed that younger individuals are more prone to Keloid occurrence. The present study also observed a similar prevalence [18].

The present study findings showed a male predominance (72.2%) among the keloid patients. This was in contrast with a previous study by Noishiki C et al., which reported a higher prevalence (2.7:1) in females. The present study findings contrast with the known literature [19]. This could be attributed to sociocultural factors or healthcare- seeking behaviour, where males might approach treatment more than females in our setting.

The most common keloid sites observed in this study were the pre sternal region, back, shoulders and all tension-prone areas which could be due to mechanical stress on healing wounds. Cho H et al., specifically stated that Keloid scars tend to occur in high-tension sites due to mechanical stimuli [20]. Also, Chikeobi CJ et al., state that tension-prone areas are susceptible to Keloids, and the current study also showed a consistent anatomical pattern [21].

The initial lesion size was slightly larger in the combination group, although not significantly different. The duration of keloid was longer in Group 1 (mean of 4.5 years) compared to Group 2 (3 years). Prolonged duration is a recognised negative prognostic factor, as chronic keloids exhibit denser collagen cross-linking and lower metabolic turnover, rendering them less responsive to therapy. This baseline imbalance, although not statistically significant, may have contributed to the inferior outcomes in Group 1. This aligns with findings from study by Bekkers V et al., [22]. They emphasise the importance of early intervention in improving therapeutic outcomes in keloid treatment.

Treatment efficacy was measured by reduction in lesion size and VSS scores over 18 weeks with 3-week intervals. Group 2 exhibited a more rapid decline in VSS scores and achieved substantially higher complete resolution rates at 18 weeks (88.9% vs. 66.67% in Group 1). This might be because of the addition of hyaluronidase to the steroid injection. These results corroborate previous clinical studies, such as Ehsani A et al., and Limmer EE and Glass DA which reported enhanced outcomes with the addition of hyaluronidase to corticosteroids [23,24].

Hyaluronidase facilitates the breakdown of the extracellular matrix and increases the diffusion of triamcinolone, thereby improving its bioavailability and clinical effect. Additionally, hyaluronidase may exert a direct antifibrotic effect by modulating fibroblast proliferation and collagen synthesis, further supporting its therapeutic role [25]. Intralesional TAC at a concentration of 20 mg/mL produces good to excellent clinical improvement in the majority of keloid patients, with outcomes that are comparable to those reported in the literature with the conventional 40 mg/mL preparation. Although adverse effects may still occur with the 20 mg/mL concentration, their frequency and severity are considerably lower than those observed with the 40 mg/mL concentration [9].

In the present study, Group 1 had local adverse effects such as hypopigmentation, pain, atrophy, and telangiectasia, which are well-documented complications of intralesional steroids. Group 2 experienced fewer such adverse effects. This observation supports the hypothesis that hyaluronidase may reduce the local concentration of triamcinolone in superficial tissues, thereby minimising steroid-related adverse effects while maintaining therapeutic efficacy.

A key strength of the present study lies in its methodological design, which ensured that both treatment arms received an identical TAC concentration (20 mg/mL) and dose per injection site (2 mg per 0.1 mL). This deliberate standardisation eliminated any confounding influence of differing corticosteroid concentrations or total steroid exposure per session. Consequently, observed differences in therapeutic efficacy (rate and extent of keloid regression, VSS improvement) and less side-effects can be attributed exclusively to the enzymatic action of hyaluronidase rather than to a simple dose-reduction effect of the corticosteroid. Although a trend suggested that younger patients and males responded more favourably, these differences did not reach statistical significance.

In conclusion, the present study demonstrates that the addition of hyaluronidase to intralesional TAC (20 mg/mL) significantly enhances therapeutic efficacy in keloid treatment, as evidenced by faster and more substantial reductions in VSS scores, higher rates of complete resolution (88.9% vs. 66.67% at 18 weeks), and markedly fewer local adverse effects (p=0.0001) compared to triamcinolone alone. These benefits can be attributed to hyaluronidase's role in improving corticosteroid diffusion, degrading extracellular matrix components, and potentially exerting direct antifibrotic effects. Future research should prioritise larger, multicenter randomised controlled trials to confirm these observations, explore long-term recurrence rates beyond 18 weeks, and investigate hyaluronidase's mechanisms in diverse populations.

Limitation(s)

Despite randomisation, Group 1 exhibited a longer mean keloid duration (4.5 years) than Group 2 (3 years). Although the difference was not statistically significant, this baseline imbalance represents a potential confounder that may have contributed to the comparatively poorer outcomes in Group 1 and should be considered when interpreting the results. The follow-up period was limited to 18 weeks, which does not allow for assessment of long-term recurrence, a key issue in keloid management.

CONCLUSION(S)

Based on the present study findings, the authors might conclude that the efficacy of the combination of intralesional TAC with hyaluronidase (88.9 complete resolution) is significantly greater than that of triamcinolone alone (66.7% complete resolution) in treating keloids. This combination therapy ensures faster scar softening and superior cosmetic outcomes with fewer side-effects, making it the preferred first-line treatment. Because longer keloid duration correlates with poorer outcomes, early intervention is critical for maximising therapeutic success.

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