








The Comparable Efficacy Between Tranexamic Acid Intradermal Injection and Pulsed Dye Laser for Treatment of Post-Acne Erythema: A Split-Face Therapy

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Abstract: Post-acne erythema (PAE) is persistent erythema after acne vulgaris (AV) inflammatory lesions have resolved. Pulsed dye laser (PDL) is the gold standard for vascular lesions and is effective for PAE. Tranexamic acid (TA) can reduce vascular endothelial growth, angiogenesis, and inflammation by inhibiting plasminogen activity, and can be used in PAE treatment. This case report aim to compare the clinical efficacy of intradermal TA and PDL therapy using a split-face design in a 23-year-old female with moderate AV, post-inflammatory hyperpigmentation (PIH), and PEA. Dermatological examination revealed comedones, papules, pustules, nodules, hyperpigmented macules, boxcar scars, and erythematous macules overlying the post-acne atrophic scars. In addition to acne therapy, patient received intradermal TA (5 mg/mL) on the left face and PDL therapy on the right, respectively. Outcomes were assessed at day 7 and day 14. Parameters evaluated included acne lesion count, erythema index (a^* value), and Dermatology Life Quality Index (DLQI). Both interventions led to a comparable result as such decreased a^* value by 17.8% on the TA-treated side and 16% on the PDL-treated side. The DLQI score also improved. Both treatment modalities are effective for PAE and repeated sessions are necessary to achieve optimal results. Intradermal TA demonstrates comparable short-term efficacy to PDL in reducing PAE and may represent a safe, cost-effective alternative, particularly in resource-limited settings. Further studies with larger cohorts are needed to validate these findings.

Keywords: acne vulgaris, post-acne erythema, pulsed dye laser, tranexamic acid

Introduction

Acne vulgaris (AV) is a common disorder of the pilosebaceous unit and is primarily observed in adolescents. AVs typically present with a pleomorphic variety of lesions, consisting of comedones, papules, pustules, and nodules with varying degrees of severity.^{1,2} AV tend to regress after the age of 25, but 7–17% of cases can persist into adulthood.³ Based on the study by Ruchiatan et al⁴ during the 5 years period data from the outpatient Aesthetic and Cosmetic Dermatology Clinic, Dr. Hasan Sadikin Hospital, Bandung, Indonesia, the most prevalent AV were found in female patients age 20–24 years.

Acne vulgaris is a non-life-threatening skin disorder that is self-limiting but often has lasting psychological and socioeconomic impacts on patients for a considerable time, even for a lifetime.^{5,6} AV patients also frequently complain of persistent hyperpigmentation or erythema after inflammatory lesions have resolved,⁶ known as post-inflammatory hyperpigmentation (PIH) and post-acne erythema (PAE).⁷ Inflammation plays a central role to persistent vasodilatation, capillary hyperplasia, and subsequent melanin synthesis abnormalities culminating in PIH. Meanwhile, PAE is characterized by erythematous macules and telangiectasias resulting from acne-induced skin inflammation,⁸ leading to

changes in the microvascular system in the superficial dermis. PAE can resolve spontaneously within approximately 12 months but can also persist, causing frustration and stress in patients.⁹

Current management approaches for PAE include topical agents, such as tranexamic acid (TA), timolol, and vitamin C, along with photoelectric therapies, such as intense pulsed light (IPL) and pulsed dye laser (PDL).^{10,11} PDL is the gold standard for vascular lesions and has been reported in various studies as an effective therapy for PAE without side effects. PDL treatment is relatively expensive and may be a barrier in some patients.^{7,12} PDL is not always readily available in every clinical setting. This is because of its high cost and the need for specialized equipment and trained personnel. TA has emerged as a treatment option for PAE, offering a practical alternative when PDL is not accessible or feasible. PDL and TA are two modalities that have shown efficacy in reducing PAE through different mechanisms. PDL targets dilated superficial vessels and dermal inflammation via selective photothermolysis, while TA exerts anti-inflammatory and anti-angiogenic effects by inhibiting plasminogen activation. Despite their increasing use, direct comparisons between these treatments are lacking. Additionally, the patient in this report had Fitzpatrick skin phototype IV, which is known to exhibit greater vascular sensitivity and pigmentary response factors that may influence the therapeutic outcomes of both TA and PDL. Hence, TA can be useful in the treatment of PAE. Given these limitations, TA has been recognized as an alternative treatment option for PAE.¹³ To objectively assess the reduction in erythema, this study utilized the a^* value derived from colorimetric analysis. This objective measurement provides a standardized method to evaluate treatment response over time.

This study aimed to evaluate the efficacy of TA intradermal injection and PDL in the treatment of PAE with split-face therapy in a 23-year-old female patient.

Clinical Case

A 23-year-old female student presented to the Aesthetic and Cosmetic Dermatology Division Clinic at Dr. Hasan Sadikin Hospital Bandung with the chief complaint of acne and erythematous macules on her face. The skin lesions initially appeared in the form of comedones, papules, pustules, and nodules on the face three years prior to the patient's visit. The patient started seeking treatment from a dermatologist and was administered various topical treatments. She experienced improvement during this time, with episodes of flare and remission, scars on the left side, and erythematous macules. Six months prior, the patient complained of recurrence. The patient consulted a dermatologist and was administered systemic antibiotics; however, there was no improvement, and the patient visited Dr. Hasan Sadikin Hospital Bandung for further treatment. Acne worsened before menstruation and during stress. There had no family history of acne. The patient denied any history of herpes on her face, isotretinoin use in the past six months, or a history of rosacea.

On physical examination, the patient's general status was within the normal limits. The dermatological state showed open comedones, closed comedones, papules, pustules, nodules, hyperpigmented macules, boxcar-type post-acne scars, and erythematous macules overlying post-acne atrophic scars on the face, including the forehead, cheek, and part of the chin. Nine comedones, eight papules, two pustules, two nodules, and erythematous macules overlying the post-acne atrophic scars were found on the right side of the face. Five comedones, six papules, and two pustules were found on the left side of the face, and erythematous macules overlaid the post-acne atrophic scars. There were 34 facial acne lesions. The patient presented with moderate AV, which was classified using the Global Acne Grading System. According to the Lehman classification, this includes moderate-grade AV. The PAE persisted for several months after resolution of active acne lesions, predominantly in the malar regions. This reflects the vascular and inflammatory sequelae characteristic of PAE. A spectrophotometric examination was conducted on both cheeks to measure erythema in PAE, and the average result of a^* on the left side was 14.63 and on the right side was 14.53. We also evaluated the impact of the disease on the patient's quality of life using the Dermatology Life Quality Index (DLQI), and the patient scored 8 (medium impact).

The patient was diagnosed as having moderate AV, post-inflammatory hyperpigmentation (PIH), and PAE. The patient was administered benzoyl peroxide (5%), topical retinoids, and topical antibiotics for AV treatment. For PAE treatment we did a split-face observation. On the left side of the face, anesthetic cream were applied for 45 minutes followed by antiseptic using 70% alcohol prior to injection. The intradermal 0.05 mL TA was injected per point using a 31-gauge insulin syringe at a concentration of 5 mg/mL, until a small wheal was observed as a confirmation of correct intradermal placement. The total dose administered did not exceed 1 mL. Respectively, on the right side, the VBeam Laser[®] procedure was performed with the following parameters: fluence, 9 J/cm², pulse duration, 10 ms, and low cooling until endpoint erythema was achieved.

Table 1 Comparison of Clinical, Objective, and Subjective Parameters Between Treatments

Visit Date	Total Acne Lesions - TA (Left)	Total Acne Lesions - PDL (Right)	a* Value - TA (Left)	a* Value - PDL (Right)	DLQI Score
Baseline	13	21	14.63	14.53	8
Week 1	9	15	12.75	12.94	-
Week 2	9	12	12.03	12.2	7

The patient was evaluated at baseline, week 1, and week 2. Outcome assessments were carried out at each visit, including acne lesion count, erythema index (a* value) using spectrophotometry, and DLQI scoring (Table 1).

On visual photography, clinical improvement was seen as the erythema on both cheeks decreased two weeks after therapy (Figure 1A–C and 2A–C). According to Spectrophotometric analysis showed that the side of the face treated with TA intradermal injection showed decrease in erythema (a*) intensity of 17.8%, whereas the side of the PDL-treated side showed a 16% decrease. The DLQI, measured after one treatment session, decreased to seven (medium impact). The patient received TA intradermal injection of 5 mg/mL and PDL therapy in one session; to achieve optimal PAE improvement, the procedure was planned to continue within four weeks interval until satisfactory outcome marked by significant decrease of erythema was achieved. Furthermore, the patient showed improvement in AV, indicating that the total number of lesions was reduced to 21.

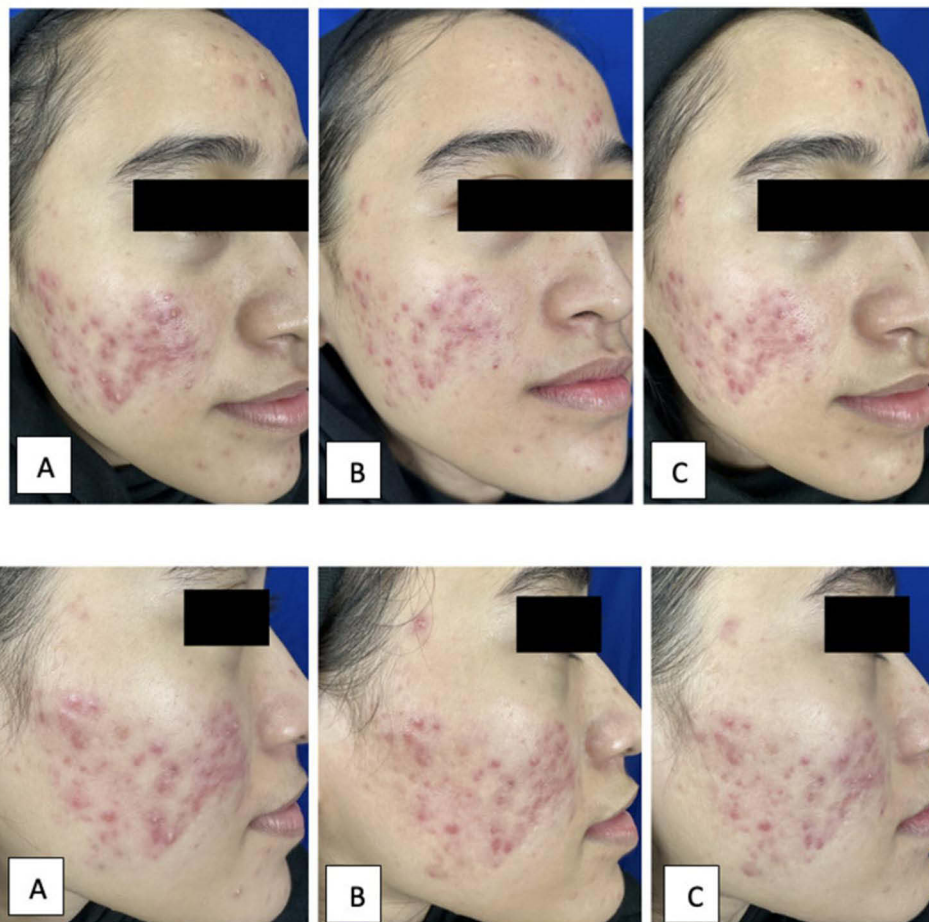


Figure 1 (A–C) Clinical manifestations on the pulsed-dye laser treated side. (A) before treatment, (B) one week after treatment, (C) two weeks after treatment.



Figure 2 (A–C) Clinical manifestations on the tranexamic acid intradermal injection 5 mg/mL. (A) before treatment, (B) one week after treatment, (C) two weeks after treatment.

Discussion

Acne vulgaris is a common, chronic inflammatory disorder of the pilosebaceous unit (comprising the hair follicle and sebaceous gland) caused primarily by increased sebum production, follicular epidermal hyperproliferation, presence and activity of *C. acnes*, inflammation and immune response.¹ The condition is characterized by chronic or recurrent development of comedones, erythematous papules, pustules, nodules, or cyst most commonly on the face but may also involve the neck, trunk, and proximal upper extremities.^{1,14} The severity of AV can be assessed using several methods, one of which is the Lehman method.¹⁵ This method classified AV into three degrees: mild (less than 20 comedones, or less than 15 pustules, no cysts, or a total of fewer than 30 lesions), moderate (20–100 comedones, or 15–50 pustules, fewer than 5 cysts, or a total of 30–125 lesions), and severe (more than 100 comedones, or more than 50 pustules, more than 5 cysts, or a total of more than 125 lesions).¹⁶ This case report presents a 23-years old female patient and classified as moderate grade of AV because the lesions on the face include closed comedones, open comedones, erythematous papules, and nodules, with a total of 34 lesions and no cysts.

Several complications are associated with AV. Inflammation plays a central role in persistent vasodilatation, capillary hyperplasia, and subsequent abnormalities in melanin synthesis, culminating in the development of PIH. These pigmentary complications affect a wide range of individual, particularly those with Fitzpatrick skin types III through IV.¹⁰ PAE emerges from inflammatory acne and persists after its resolution. It is characterized by telangiectasia and erythematous

macules.¹⁷ It is related to the secretion of inflammatory cytokines, such as interleukin (IL)-6 and tumor necrosis factor (TNF)- α . Intracapillary aggregations of erythrocytes and microcapillary dilatation caused by the healing process in the papillary dermis play crucial roles in the development of PAE.¹⁸ Furthermore, as a wound heals, the epidermis becomes thinner, making dilated microcapillaries more visible.^{7,19} These skin condition can heal by itself, but in some cases, PAE can persist.^{7,8} Some lesions may last for two to six months.⁷ After vasoconstriction for hemostasis, vasodilation occurs, resulting in erythema. This process plays an important role in the formation of PAE.²⁰ The complication of our patient revealed PAE because after acne improves left marks as macule erythema.

Acne vulgaris typically affects important cosmetic areas (such as the face, neck, and chest), with a risk of permanent scarring. The aesthetic impact of this condition has significant impact and affect on quality of life (QoL).²¹ The impact may be more in females resulting in higher psychosocial problems.²² The DLQI is a brief skin-specific questionnaire consisting of 10 questions that measure patients' QoL: acne symptoms, feelings, relationships, work and study, sleep, leisure activities, and treatment. A higher DLQI score means more impairments in QoL.²³ On the first day of observation, the patient in this case report had a DLQI score of 8, indicating a medium impact on their life.

In moderate acne, combination therapy has shown the most favorable results and typically consists of a regimen including benzoyl peroxide (BPO), topical antibiotics,^{24,25} and a topical retinoid.^{26,27} Treatment for PAE vary widely, including radiofrequency, isotretinoin, PDL, adrenergic receptor agonists, and intense pulsed light device.¹³ Numerous topical medications, such as 12.5% glycolic acid, 0.2% brimonidine tartrate, 5% tranexamic acid solution, and vitamin C formulations have been used with varying degrees of success for PAE.^{28,29} There is no standard treatment, and the number of published clinical studies is limited. TA and PDL treatment have been used to treat PAE.⁸ While both PDL and TA are widely used in the management of PAE, comparative data using a split-face design are still limited. This case contributes to the growing clinical evidence by providing a side-by-side evaluation of these two therapeutic options in a patient with symmetrical lesions, thereby offering a practical perspective for individualized treatment selection.

Given the greater difficulty in treating PAE in patients with higher Fitzpatrick skin types, and the significant psychosocial burden it presents, exploring safe, accessible, and effective treatment combinations such as intradermal TA is of high clinical relevance. The potential of intradermal TA as adjunct to laser therapy. TA is an antifibrinolytic agent that binds reversibly to plasminogen and prevents its conversion into plasmin. TA can also reduce the activity of vascular endothelial growth factor and endothelin-1, thereby decreasing angiogenesis, pro-inflammatory factors, inflammation, and melanogenesis by inhibiting plasminogen activity. Therefore, TA has three major beneficial effects, including lightening, anti-inflammatory, and anti-redness effects.^{13,30} Hence, TA can be useful in the treatment of PAE. Study at Bazargan et al¹⁴ showed significant improvement in TA injection due to its anti-inflammatory and anti-redness effects in the treatment of PAE. Charoenwattanayothin et al³¹ evaluated the efficacy of 10% TA serum for the treatment of AV and PAE. After 8 weeks of use, acne counts in the total inflammatory acne group were significantly reduced on the TA side. TA reduced papules and pustules, but nodule counts did not differ significantly. It was also noted that the TA side showed reduced skin redness, as well as PAE. The patient in this case report, using TA intradermal injections of 5 mg/mL on the left facial erythema, was monitored one and two weeks after the procedure, and a reduction in PAE was observed after two weeks of therapy. Furthermore, the number of inflammatory acne lesions was reduced to four papules and one pustule.

According to Badran et al.³² TA intradermal injections are more effective than topical TA injections. Moreover, side effects associated with topical TA, such as erythema, itching, and burning sensations, can prevent long-term use and reduce patient compliance. A study by Bazargan et al¹⁴ showed that intradermal injection of TA with local anesthesia resulted in mild-to-moderate pain in patients and was tolerable for all patients. After treatment, patients mentioned that the swelling had disappeared by the end of the treatment day, the erythema at the injection site had disappeared within 2–3 days, and there were no side effects, such as persistent swelling or inflammation. Intradermal injections target the delivery of medications directly to the target area to avoid systemic effects. TA is a noninvasive, accessible, and cost-effective option that avoids procedural risks and downtime associated with PDL. It is better tolerated, especially in darker skin types, owing to the lower risk of post-inflammatory hyperpigmentation. In this patient, swelling and redness were observed at the injection site, which disappeared within one day.

Recent studies have demonstrated that PDL therapy is the most effective modality among non-ablative laser-based devices in the management of inflammatory acne.^{7,32} PDL offers significant advantages in the treatment of PAE owing to

its highly targeted mechanism of action. PDL therapy has been reported to improve acne severity and reduce acne lesion count. PDL produces light that is primarily absorbed by oxyhemoglobin, making it suitable for targeting superficial vascular lesions such as small blood vessels and diffuse erythema, which can reduce PAE.^{33,34} Additionally, the light is also absorbed by porphyrins produced by *C. acnes*, leading to the formation of oxidative agents that can kill the bacteria, thereby reducing bacterial colonization.^{35,36} Seaton et al³⁷ reported that low-fluence PDL improved inflammatory facial acne 12 weeks after a single session with no serious side effects. PDL emits light with a wavelength of 577 nm, while newer PDLs have wavelengths of 585 nm or 595 nm. Study by Yoon et al⁷ demonstrated that treating inflammatory acne lesions with a long-pulse 595 nm PDL resulted in positive results, including a reduction in the number of lesions and severity of erythema after eight weeks. The side effects of PDL laser include erythema, hyperpigmentation, hypopigmentation, atrophic scars, and dermatitis, but their occurrence is very rare.³⁷ Purpura is the most apparent side effect of PDL treatment that arises during treatment and remains clinically apparent for 2–14 days.³⁸ Furthermore, PDL minimizes systemic side effects and allows localized treatment, making it a safe and efficient option under controlled clinical settings. Despite its effectiveness in targeting vascular lesions, PDL requires specialized equipment and trained professionals, making it less accessible and relatively more expensive than the other treatments. The PDL device used in this case report was the 2019 generation Vbeam Perfecta[®] with a wavelength of 595 nm on the right face, and no side effects were observed. Two weeks after treatment with PDL, erythema had decreased on the right side of the face, and improvement in the inflammatory acne lesions became five papules, one pustule, and no nodules, possibly due to the contribution of PDL therapy to the treatment of AV.

A split-face study was performed for AV and PAE using a Vbeam laser[®] on the right side of the face and intradermal injections of TA (5 mg/mL) on the left side. The spectrophotometer detects subtle changes in skin color that are almost undetectable to the naked eye. Moreover, errors in the level of erythema pigmentation of the skin caused by the subjective determination of examiners can be overcome by the application of a spectrophotometer. Many important facts in the spectrophotometer aspect are clinically accepted about parameters, such as $L^*a^*b^*$.³⁹ Several factors must be considered when using a spectrophotometer, such as ensuring the subject's position and room temperature are controlled. Furthermore, measurements should be repeated at the same time each day to reduce the impact of natural diurnal changes on skin color.^{40,41} Shriver et al⁴² showed value b^* and L^* are indicators of UV tanning. The a^* color factor and erythema index of both simple reflectance meters were adequate for objective measurements of erythema induced by the vasodilator.³⁹ In this case report, observations were made in the 1st and 2nd weeks. Before therapy, the average a^* values at three points on the right side of the face treated with the Vbeam laser[®] was 14.53 and in the 2nd week, was 12.20 showing decrease of erythema 16%. The average a^* values at three points on the left side of the face treated with TA injections before therapy were 14.63, and in the 2nd week, they were 12.03, indicating decrease of erythema 17.8%. Two weeks after treatment with TA intradermal injection and PDL, erythema decreased on both sides of the face, as observed by visual photography. The intensity of erythema (a^*) based on spectrophotometry decreased by 17.8% in TA intradermal injection therapy and 16% in PDL.

A comparative pilot case of intradermal TA versus PDL for PAE is still limited, particularly employing a split-face design. Highlighting noticeable comparable clinical improvement within two weeks for both modalities. The main limitation of this study is that it may limit the generalizability of our findings. These results align with recent findings supporting the efficacy of TA in reducing PAE through its vascular and anti-inflammatory effects. While the outcome is promising, the single-case design and short follow-up limit generalizability. Larger controlled studies with longer follow-up are needed to validate these observations.

Conclusion

PDL and TA significantly improved PAE. Both modalities have proven to be effective in addressing PAE, and repeated treatments are necessary to achieve optimal and sustained improvement. Therefore, both therapies are comparable and can be considered viable options for managing PAE, with the need for multiple sessions to maximize outcomes. These findings support the consideration of intradermal TA as a promising and cost-effective alternative for managing PAE, especially in settings where laser therapy is not readily available. Further studies with larger cohorts and longer follow-up are needed to validate its efficacy and long-term safety.

Ethic Statement

This case report was approved by The Research Ethics Committee of Dr. Hasan Sadikin General Hospital Bandung with approval number DP.04.03/D.XIV.6.5/299/2025.

Consent Statement

The authors certify that they have obtained all appropriate patient consent forms. The patient provided written informed consent for the publication of this case and the accompanying clinical images.

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Disclosure

The authors report no conflicts of interest in this work.

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