Effectiveness of the long-pulsed ND:YAG 1064 nm laser with 15% vitamin C (L-acid ascorbate) solution combination therapy in the treatment of patients with atrophic acne scars

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Background: Vitamin C and long-pulsed Laser Nd:YAG 1064 nm can reduce the severity of acne scars by increasing the number and density of collagen fibers. Furthermore, applying vitamin C after the skin resurfaces can improve its penetration into the skin. This study aimed to prove the difference between the effectiveness of the long-pulsed Nd:YAG 1064 nm laser with 15% vitamin C (L-ascorbic acid) solution combination therapy and isolated long-pulsed Nd: YAG 1064 nm laser therapy in atrophic acne scars by assessing the decrease in Goodman and Baron scores.

Methods: This study took the form of a double-blind, randomized controlled trial using a pretest-posttest comparison group design on patients with atrophy acne scars on the face. Both groups were assessed using the Goodman and Baron scores before and after therapy for three months. Subsequently, descriptive analysis and hypothesis testing were performed.

Results: In the treatment group, the mean Goodman and Baron score decreased significantly after treatment to 13.9 ± 7.39 (P = 0.008), while in the control group, the mean score decreased significantly to 18.2 ± 9.34 (P = 0.007). Goodman and Baron Delta scores in the treatment group were significantly higher at 7.3 ± 2.78 compared with the control group at 3.1 ± 1.05 (P < 0.001).

Conclusion: Long-pulsed Nd:YAG 1064 nm laser with 15% vitamin C solution (L-ascorbic acid) combination therapy is more effective in lowering the Goodman and Baron scores for atrophic acne scars than isolated long-pulsed Nd:YAG 1064 nm laser.

Keywords: scars, L-ascorbic acid, vitamin C

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INTRODUCTION

Acne scars start at the site of tissue injury due to acne vulgaris [1]. Acne vulgaris is a chronic inflammatory disorder in the pilosebaceous unit characterized by the presence of blackheads (either open, closed, or both) accompanied by inflammatory lesions such as papules, pustules, or nodules [2-4]. The rate of acne scars is estimated to be 11% in men and 14% in women. Acne scars can be either atrophic or hypertrophic. Atrophic scars are skin depressions that form due to collagen destruction, occurring after the inflammatory process. Hypertrophic scars are prominent protrusions on the skin. The occurrence of atrophic acne scars is around 80%–90% [4].

A non-ablative laser is a therapeutic option for atrophic acne scars. Compared with laser ablation, non-ablative laser therapy has fewer side effects

like erythema and dyspigmentation. The long-pulsed Nd:YAG 1064 nm laser is known to be safer because of the application of controlled heat to the dermis, which can further trigger neocollagenesis and remodeling in acne scars [2]. The results are often unsatisfactory when using non-ablation laser as monotherapy; hence, some therapy combinations can be used to treat acne scars.

Vitamin C can play a role in collagen formation as a proline cofactor and lysine hydroxylase that stabilizes collagen's tertiary structure and triggers the expression of collagen genes by increasing the rate of procollagen mRNA transcription. Research shows that topical application of vitamin C can increase the concentration of vitamin C in the skin by 20 times [5].

This study aims to prove the difference between the effectiveness of long-pulsed Nd:YAG 1064 nm laser with 15% vitamin C (L-ascorbic acid) solution combination therapy and isolated long-pulsed Nd:YAG 1064 nm laser therapy atrophy in acne scars.

PARTICIPANTS AND METHODS

Participants and study design

This study was a double-blind, randomized controlled trial using a pretest-posttest comparison group design. There were 18 participants aged 18–45 years with mild to severe atrophic acne scars, for which they sought treatment at the Dermatology Clinic of RSND Semarang.

Research subjects were divided into two groups by consecutive sampling based on the arrival of the research subjects until the sample was fulfilled. The inclusion criteria were individuals aged 18–55 years old, mild to severe atrophic acne scars, scar duration of one year or more, and willingness to participate in the research and obtain appropriate therapy by the division of research groups. Patients who were pregnant or breastfeeding or had lesions with an active infection in the acne scar area, a history of hypertrophic or keloid scars, active or recurrent herpes simplex, oral retinoid consumption within six months before the first visit, photosensitivity, immunosuppression, using other skincare products for acne and acne scars within two weeks before the first visit, or undergoing cosmetic procedures on the face (laser resurfacing, dermabrasion, and chemical peels) within six months before the first visit were excluded from the research.

All patients in both groups were assigned to receive treatment with a long-pulsed Nd:YAG 1064 nm laser every month for three months. In addition, the patients were randomized to receive 15% L-ascorbic acid topical solution or placebo solution, based on a randomization table provided by a statistician not otherwise involved in the study.

Clinical assessment

The first group received the long-pulsed Nd:YAG 1064 nm laser with 15% vitamin C solution (L-ascorbic acid) combination therapy. The second group had long-pulsed Nd:YAG 1064 nm therapy with the placebo. Each study subject in the first group received full facial treatment with a long-pulsed Nd:YAG 1064 nm laser with a fluence of 5 J/cm^2, a spot size of 10 mm, and a pulse rate of 10 Hz. Patients received laser treatment three times at intervals of one month for three months. Patients received an additional 15% L-ascorbic acid therapy as much as 1 ml, twice a day, topically applied on the third day after laser treatment, used for three months.

Every research subject in the second group received full facial treatment with a long-pulsed laser Nd:YAG 1064 nm with a fluence of 5 J/cm^2, a spot size of 10 mm, and a pulse rate of 10 Hz. Patients received laser treatment three times at intervals of one month for three months. The patients received an additional 1 ml of topical placebo solution, twice a day, topically applied for three months.

The patients were evaluated before the procedure and after one and three months. The evaluation was performed using a quantitative assessment of the severity of acne scars with Goodman and Baron scores. All patients were photographically documented using a Canon 450 D camera.

The Goodman and Baron scores assessment was carried out by three individuals (one researcher and two companions, including a dermatologist). The measurement was done in every treatment session. The benefit of measuring the acne scar using Goodman and Baron scores is that it can quantitatively reflect the condition of atrophic scars on the face [4]. In the assessment, there was a decrease in the Goodman and Baron scores before

and after the treatment in each group, and a comparison of the decrease in Goodman and Baron scores between the two groups was conducted.

Statistical methods

Statistical data analysis was performed using the SPSS computer program with the unpaired t-test, Fisher's exact test, Mann–Whitney U test, and Wilcoxon test**.** Differences were considered significant if $P < 0.05$.

Ethical considerations

Before the study was conducted, the research protocol had received ethical clearance from the Research Ethics Commission of the Faculty of Medicine UNDIP/Dr. Kariadi Semarang No. 22/EC/KEPK/FK-UNDIP/V/2019.

RESULTS

The study involved 18 patients with atrophic acne scars on the face, and no subject dropped out after both groups received treatment for three months. The mean age of the subjects was 33.7 ± 6.02 years in the first group and 30.0 ± 7.95 years in the second group. Our participants included 8 men (44.4%) and 10 women (55.6%). The demographics (age, sex, level of education, and occupation) were balanced between the two groups; the unpaired t-test and Fisher's exact test revealed no significant differences between the groups in terms of the demographics ($P > 0.05$).

The mean Goodman and Baron score in the control group (21.3 ± 10.17) was slightly higher than in the treatment group (20.9 ± 9.54). Still, the statistical analysis showed that the difference was not significant ($P = 0.8$).

The mean post-treatment Goodman and Baron score of the first group (13.9 ± 7.39) was lower than that of the second group (18.2 ± 9.34), but the results of the statistical tests showed that the difference was not significant ($P = 0.3$).

The mean Goodman and Baron score in the first group just before treatment was 20.9 ± 9.54, whereas after treatment, it dropped significantly to 13.9 ± 7.39 ($P = 0.008$; Wilcoxon Test). In the second group, before treatment, the mean Goodman and Baron score was 21.3 ± 10.17, but decreased to 18.2 ± 9.34 after treatment ($P = 0.007$; Wilcoxon Test).

The Goodman and Baron Delta score in the first group was significantly greater at 7.3 ± 2.78 compared with the second group, which was at 3.1 ± 1.05 ($P < 0.001$). The median value of the Goodman and Baron Delta score in the first group was higher than that in the second group. This shows that the change in the Goodman and Baron score in the treatment group was greater than that of the control group ($P < 0.001$).

Most study subjects, as many as 11 people (61.1%), did not complain about side effects after receiving either therapy. A total of seven study subjects (38.9%) complained of erythema or redness. Side effects after laser treatment in patients include erythema, which disappears with compressing and does not settle until the patient returns.

DISCUSSION

Acne scars are generally formed as a result of the healing process and repair of natural tissues after inflammation caused by acne. Atrophic acne scars are formed due to reduced collagen production during the wound healing process [2].

The long-pulsed Nd:YAG 1064 nm laser is used as a non-ablative laser that provides an optimal effect against therapeutic targets without damaging the epidermis. The laser is safe to use, has minimal side effects, and results in rapid recovery [6]. The use of long-pulsed laser Nd:YAG 1064 nm therapy can improve the quality of the tissue remodeling process and reduce the severity of acne scars by reducing MMP production while increasing the number and density of collagen and fibroblast fibers. The long-pulsed Nd:YAG 1064 nm laser prevents heat shock protein 70 and procollagen I from spreading on dendritic cells in the papillary dermis and reticular dermis, thereby increasing collagen deposition in the papillary dermis [1]. Research by Lee *et al.* mentioned an increase in the amount and density of collagen fibers in the papillary dermis, which increased up to eight weeks after laser treatment [7].

A recent study demonstrated the efficacy of long-pulsed Nd:YAG was initially higher than that of fractional Er:YAG laser in improving facial skin wrinkles with minimal to no downtime, and they can be a more favorable choice [8]. In our study,

long-pulsed Nd:YAG 1064 nm laser and topical vitamin C resulted in a significant decrease in the Goodman and Baron score with minimal to no downtime.

In a study comparing 585-nm pulsed dye laser with long-pulsed Nd:YAG 1064-nm laser for the treatment of acne scars, greater improvement was seen with Nd:YAG laser along with histologic improvements evidenced by procollagen I formation. These findings suggest that optimal outcomes might be achieved when laser treatment types are chosen after considering individual conditions and the response during treatment [1]. Our study demonstrated the efficacy of vitamin C as an adjunct to long-pulsed Nd:YAG 1064 nm laser, providing a synergistic effect in stimulating collagen formation.

The study by Friedman *et al.* demonstrated that treatment with the non-ablative 1064-nm Q-switched Nd:YAG laser results in significant quantitative improvements in skin topography in patients with mild to moderate atrophic acne scars. Continued incremental improvements were noted at 1, 3, and 6 months of follow-up, indicating ongoing dermal collagen remodeling after the treatment [9]. Our study involved long-pulsed Nd:YAG 1064 nm laser therapy every month for three months, and the Goodman and Baron scores showed continued improvements after 1, 2, 3, and 4 months.

The long-pulsed Nd:YAG 1064 nm laser with 15% vitamin C solution (L-ascorbic acid) combination therapy, which the first group received, has a role in wound healing, and this is directly related to collagen synthesis. Previous research showed that topical vitamin C administration could significantly reduce scar formation in Asian populations [10]. Furthermore, previous studies have evaluated the use of vitamin C therapy before resurfacing therapy. Vitamin C treatment has been shown to accelerate the process of re-epithelialization and healing after resurfacing therapy by stimulating collagen production [11], such that the use of vitamin C in research has become more effective as a therapy for the second and third long-pulsed Nd:YAG 1064 nm laser treatment sessions. The use of laser resurfacing therapy can cause dermis injuries of various depths. The use of good techniques to control the depth of injury during laser resurfacing procedures appears to play an important role in the efficacy and safety of the therapy. Histological studies have found that the speed of re-epithelialization is generally directly proportional to the depth of injury caused by the resurfacing procedure. Therefore, vitamin C (L-ascorbic acid) can provide more optimal benefits after performing therapeutic procedures that increase the production of type I collagen [12].

No previous studies regarding the difference of effectiveness between long-pulsed Nd:YAG 1064 nm laser with 5% vitamin C solution (L-ascorbic acid) combination therapy and isolated long-pulsed Nd:YAG 1064 nm laser therapy have been conducted in patients with atrophic acne scars. This study found that the treatment group's Goodman and Baron Delta score was significantly greater at 7.3 ± 2.78 compared with the control group at 3.1 ± 1.05 ($P < 0.001$). The long-pulsed Nd:YAG 1064 nm laser applies controlled heat to the dermis, which can further trigger neocollagenesis and remodeling in acne scars [2]. The results obtained are often unsatisfactory if used as a single therapy, so combination therapies (one of them is the 585-nm pulsed dye laser and the long-pulsed Nd:YAG 1064 nm laser) [7] are often used. Further research is needed over a more extended period to get more comprehensive results.

CONCLUSION

The long-pulsed Nd:YAG 1064 nm laser with 15% vitamin C solution (L-ascorbic acid) combination therapy is more effective in lowering the Goodman and Baron scores than isolated long-pulsed Nd:YAG 1064 nm laser therapy for atrophic acne scars.

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Conflict of Interest: None declared.

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