Comparison of non-ablative and ablative fractional laser treatment in postoperative scars

Dorjsuren Gantsetseg

Department of Medicine

The Graduate School, Yonsei University

Comparison of non-ablative and ablative fractional laser treatment in postoperative scars

Directed by Professor Ju Hee Lee

The Master's Thesis
submitted to the Department of Medicine,
the Graduate School of Yonsei University
in partial fulfillment of the requirements for the degree
of Master of Medical Science

Dorjsuren Gantsetseg

December 2010

This certifies that the Master's Thesis of Dorjsuren Gantsetseg is approved.

____

Thesis Supervisor: Ju Hee Lee

____

Thesis Committee Member: Kee Yang Chung

____

Thesis Committee Member: Dong Kyun Rah

The Graduate School
Yonsei University

December 2010

Acknowledgements

I appreciate professor Ju Hee Lee, M.D., Ph.D., Department of Dermatology, Yonsei University College of Medicine, Seoul, Korea. She supervised and encouraged me to study this subject.

I also appreciate professor Kee Yang Chung, M.D., Ph.D., and Dong Kyun Rah, M.D., Ph.D.. They gave me experienced advices and warm support.

I could not forget the warm support of Jin Young Jung, M.D.. I am very grateful to Nam Soo Jang for technical assistance.

I am especially grateful to my parents and my family, who have tolerated the years of my study with patience. I give my love and admiration to them.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Comparison of non-ablative and ablative fractional laser treatment in postoperative scar

Dorjsuren Gantsetseg

Department of Medicine
The Graduate School, Yonsei University

(Directed by Professor Ju Hee Lee)

Postoperative scarring following thyroidectomy is a problem for both patients and clinicians. Recently, both nonablative and ablative fractional laser systems (NFL and AFL) have attracted attention in the revision of thyroidectomy scars. The present split-scar study was designed to compare the efficacy of these two systems for post-thyroidectomy scars.

Twenty females (mean age 42.1 years, range 22-55) with scarring 2-3 months post thyroidectomy were enrolled in the study. One half of the scar (chosen at random) was treated with NFL and the other half with AFL (MOSAIC™ and eCO2™, Lutronic, Ilsan, Korea). Two treatments were given two months apart. Clinical photographs were taken at baseline, before each treatment and at the final three-month evaluation, when both independent clinician grading of improvement and patient satisfaction were measured on a quartile scale. Color (erythema and melanin indices, EI & MI) and scar hardness were measured at baseline and at three months posttreatment with a dermaspectrometer and durometer, respectively.

AFL was graded better than NFL by clinicians and patients in 7 and 6 patients, respectively, NFL versus AFL in 6 and 5 patients, respectively, and equal grading in 7 and 9 patients, respectively. The mean clinical improvement grades for AFL and NFL were 2.45±0.99 and 2.35±0.85, respectively, without statistical significance (*p*=0.752). Fourteen patients were very satisfied or satisfied with AFL compared with 13 patients for the NFL, and 2 patients were dissatisfied with both approaches. The EI and MI were significantly better for NFL versus AFL (*p*=0.035, *p*=0.003, respectively) and hardness was significantly better for AFL (*p*=0.026). Mild hypertrophic scarring was seen in 2 patients.

Clinical improvement was not significantly different between the two systems, whereas AFL was better for scar hardness and NFL for color. These data suggest that a study with a combined approach might be merited in the revision of post-thyroidectomy scarring.

Key words: erythema index, fractional laser technology, hypertrophic scar, melanin index, scar revision

Comparison of non-ablative and ablative fractional laser treatment in postoperative scar study

Dorjsuren Gantsetseg

Department of Medicine
The Graduate School, Yonsei University

(Directed by Professor Ju Hee Lee)

I. INTRODUCTION

Postoperative hypertrophic scars can present an aesthetic problem for both patients and clinicians. In the case of hypertrophic scarring following a thyroidectomy for cancer of the thyroid, the incision site is clearly visible on the neck, although the surgeon will usually have tried to follow and incise skin fold to help the final cosmesis. However, the degree of motion and thin nature of the skin of the neck makes this an area prone to hypertrophic scar formation. In female patients in particular, who form the majority of thyroidectomy patients for thyroid disease[1], the presence of clearly-visible hypertrophic scarring of the lower neck can have strong negative psychosomatic potential.

A number of surgical and nonsurgical approaches have been proposed for the treatment of scars, including some lasers, with varying degrees of success. The development of nonablative fractionated laser (NFL) technology offered the so-called fractional thermolysis technique with minimal sequelae and short patient downtime, and presented a new tool for the successful treatment of various scar types[2,3]. It has even been shown to be superior to the pulsed dye laser for the treatment of surgical scars[4]. The appearance of ablative fractional laser (AFL) technology brought yet another approach with slightly more noticeable sequelae and a little more downtime. The AFL approach has been widely used in rejuvenation, and also in the treatment of some scar types[5,6]. The neck is, however, an anatomical area which has proved resistant to frank ablative laser resurfacing, but the fractional ablative CO_2 laser has proved very effective in treating the neck[7]. A previous report suggested that treatment using an erbium-glass (Er:Glass) NFL might decrease the incidence of hypertrophic scarring and accelerate the improvement of postoperative scars[8]. A more recent study has examined the efficacy of a CO_2 AFL for hypertrophic post-thyroidectomy scars, with good results[9]. No study to our knowledge has compared the efficacy of NFL with AFL in the treatment of post-thyroidectomy scars, and so the present comparative split-scar study was designed to assess and compare the efficacy of these two different fractional technologies in the treatment of post-thyroidectomy scars.

II. MATERIALS AND METHODS

1. Subjects

Twenty females (mean age 42.1 years, range 22-55) of Fitzpatrick skin types III–V with scarring 2-3 months post-thyroidectomy were enrolled in the study. Exclusion criteria were a history of keloid formation, isotretinoin use, pregnancy, immunosuppressive drug use, or inflammation or infection of the postoperative scar. Our protocol and informed consent were approved by the Institutional Review Board of Severance Hospital, Yonsei University College of Medicine, Seoul, Korea. Having been informed of the purpose, methods and possible outcomes of the trial, all participants provided written informed consent to participate in the trial and for the use of their clinical photography.

2. Treatment

The lasers used in the trial were the Mosaic™ NFL system and the eCO2 AFL system, both from Lutronic Corporation, Ilsan, Korea. The NFL system was based on a 1,550 nm Er:glass laser and the AFL on a 10,600 nm CO_2 laser. One side of the scar in the 20 subjects was randomized for treatment with NFL and the other with AFL. Two treatments were given, with an interval of two months.

Prior to laser treatment, the treatment area on the neck was cleansed with 70% alcohol, and topical anesthetic EMLA cream (eutectic mixture of 2.5% lidocaine HCl and 2.5% prilocaine; AstraZeneca AB, Södertälje, Sweden) was applied around the thyroidectomy scar under occlusion an hour prior to the laser treatment. The NFL settings were 50 mJ per pulse, and a spot density of 100 over a 4 x 4 cm treatment area/shot in static mode. Individual shots were carefully not overlapped and 2 passes were made. Thermal quenching to help prevent any secondary thermal damage in the spared tissue was achieved by placing a cooling pack on the treated area immediately post-treatment for 5-10 min. For the AFL treatment, the settings and method were similar to the NFL, with the exception of the pulse width which was 60 mJ/pulse, the nearest equivalent to the NFL settings.

3. Assessment of clinical efficacy

A final assessment of the result was made three months after the second treatment. Digital clinical photography under identical conditions was taken at baseline (pretreatment), before the second treatment session and at the final 3-month assessment.

Clinician assessment

Two independent dermatologists, blinded to the study design, used the baseline and final assessment photographs (not in chronological order) to make a clinical assessment. A quartile grading scale was used for this evaluation (grade 1, less than 25% = minimal to no improvement; grade 2, 26% to 50% = moderate improvement; grade 3, 51% to 75% = marked improvement; and grade 4, more than 75% = near total improvement). The scores for grades 3 and 4 were added to give the overall efficacy, expressed as a percentage of the total study population (n=20).

Subjective patient assessment

Patient satisfaction was also graded at the final 3-month assessment on a quartile scale: grade 4, very satisfied; grade 3, satisfied; grade 2, slightly satisfied; and grade 1, dissatisfied. Patients also reported any side effects of treatment, including discomfort or pain, bleeding, oozing, post-therapy dyschromias, scaling or crusting, erythema, and scarring.

Objective machine assessment

To objective by evaluate of any changes in the color and hardness of the scars, we used narrow-band reflectance spectrophotometry (DermaSpectrometer II®, Cortex Technology, Hadsund, Denmark) to assess color changes and a durometer (Rex 1600, Rex Gauge CO., Inc., Buffalo, NY, USA) to assess changes in scar hardness. The erythema index (EI) and the melanin index (MI) of scars were obtained via narrow-band reflectance spectrophotometry using the photospectrometer probe wavelengths of 568 nm and 655 nm on every visit. The EI and MI were measured for both halves of each scar (Figure 1) at the outer margin (L/R1), mid-point (L/R2) and 5 mm laterally from the centerline of the scar (L/R3), and the mean EI and MI values were used for comparison of the NFL- and AFL-treated halves. The durometer was always held perpendicular to the scar tissue to be measured and was repeated three times (immediately after touching the scar, again after the initial measurement, and once more 15 seconds later) while maintaining firm contact at the same points as for the spectrometer, oamely in the outer margin, mid-point and 5 mm laterally from the centerline of the scar; The mean value obtained from the three points was used, and compared between the NFL- and AFL-treated halves.

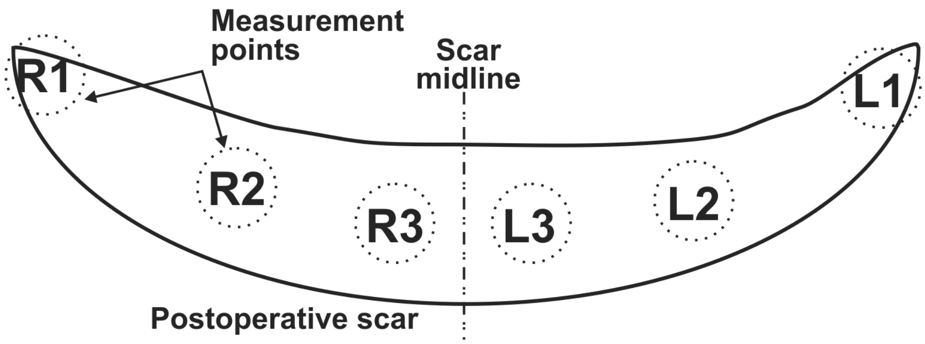

Figure 1. Schematic of the split-study aspect of the thyroidectomy scar assessment at baseline and at the final 3-month assessment showing the measurement points on both scar halves with the photospectrometer and the durometer.

4. Assessment of histological change

Skin biopsies were performed in two volunteers before treatment, one day, one week and one month after the NAF- and AFL-treated sites using a 3-mm biopsy punch. The excised skin was fixed in formalin and embedded in paraffin. Samples were stained with hematoxylin-eosin for histological assessment, and immunohistochemical assessment was performed for heat shock protein (HSP) 70, transforming growth factor β (TGF-β), matrix metalloproteinase (MMP)-2, 9 and tissue inhibitors of matrix metalloproteinase (TIMP)-1, 2. The antibodies (Abs) used for the immunohistochemical analyses were as follows. To evaluate the presence and distribution of HSP 70 in the scar, we used a purified mouse monoclonal Ab against HSP 70 (Abcam, Cambridge, UK) at a concentration of 39 μg/ml. TGF-β1 levels were assessed with a purified rabbit polyclonal Ab against TGF-β1 (Gene Tex®, Inc, CA, USA) at a concentration of 10 μg/ml. To evaluate the presence and distribution of MMP-2 in the scar, a purified rabbit polyclonal Ab against MMP-2 (Abcam, Cambridge, UK) was used at a concentration of 10 μg/ml. For the presence and distribution of MMP-9 in the scar, the Ab used was a purified rabbit monoclonal Ab against MMP-9 (Abcam, Cambridge, UK) at a concentration of 10 μg/ml. The presence and distribution of TIMP-1 in the scar immunohistochemistry was assessed with a purified mouse monoclonal Ab against TIMP-1 (Abcam, Cambridge, UK) at a concentration of 10 μg/ml. We evaluated the presence and distribution of TIMP-2 in the scar using a purified mouse monoclonal Ab against TIMP-2 (Abcam, Cambridge, UK) at a concentration of 10 μg/ml. Histological findings from the stained specimens were observed by blind inspections of the samples, but were not quantified.

5. Statistical analysis

The data from the clinician and machine assessments were analyzed for statistical significance using nonparametric Wilcoxon signed-rank test (SPSS

[Statistical Package for the Social Sciences] version 13.0, SPSS Inc., Chicago, IL, USA).

III. RESULTS

1. Degree of clinical improvement

As to which system was superior for hypertrophic post-thyroidectomy scar revision at 2-3 months post-thyroidectomy, the clinicians felt that NFL was clinically more effective than AFL in 6 patients, AFL was clinically more ddddeffective than NFL in 7 patients, and they graded the results equally in 7 patients. The actual grading points are shown in Table 1 where grade 4 (Figure 2 & 3) represents the best result and grade 1 the poorest. The mean (± SD) grades for the NFL and AFL were 2.35±0.85 and 2.45±0.99, respectively, with no significant difference (p=0.752). Overall efficacy for the NFL and AFL systems was 45% and 55%, respectively, showing a slight but insignificant trend in favour of CO_2 AFL.

Table 1. Grading of clinical efficacy of the NFL and AFL systems by the independent clinicians (based on baseline and final assessment photography) and of subjective satisfaction by the patients.

Clinician efficacy grades				
System	Grade (No of patients)			
NFL	4 (2)	3 (7)	2 (8)	1 (3)
AFL	4 (2)	3 (9)	2 (6)	1 (3)
Patient satisfaction grades				
System	Grade (No of patients)			
NFL	4 (6)	3 (7)	2 (5)	1 (2)
AFL	4 (8)	3 (6)	2 (4)	1 (2)

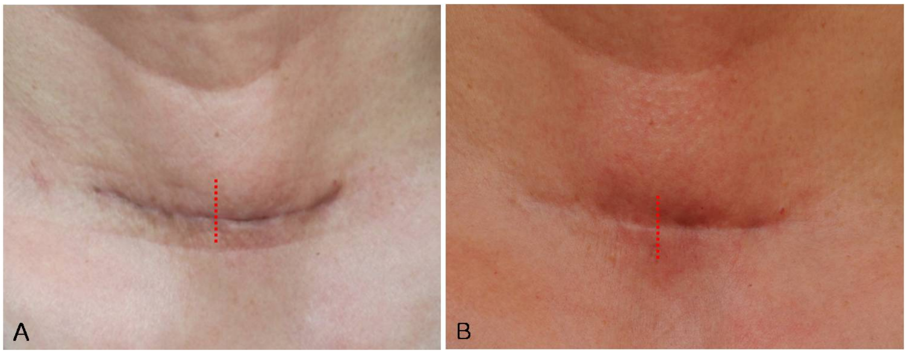

Figure 2. Comparison of clinical of thyroidectomy scar before (A) and 3 months after treatment (B) using NFL and AFL. The left side of scar was treated NFL and right side of scar was treated AFL. Improvement grade of both sites was grade 4. The improvement of hypertrophy was better at AFL treated site than NFL treated site.

Figure 3. Comparison of clinical of thyroidectomy scar before (A) and 3 months after treatment (B) using NFL and AFL. The left side of scar was treated NFL and right side of scar was treated AFL. Improvement grade of both sites was grade 3. The improvement of color was better at NFL treated site than AFL treated site.

As for the clinical efficacy of the systems, the patients felt that NFL was clinically more effective than AFL in 5 patients, AFL was more effective than NFL in 6 patients, and they graded the results equally in 9 patients, very similar to the clinician grades. The satisfaction grades are shown in Table 1, with the patient SI for the NFL and AFL systems being 65% and 70%, again showing a slight but insignificant trend in favor of CO_2 AFL.

2. Objective improvement by spectrophotometry and durometer

Table 2 summarizes the color and hardness scores. NFL was better for removing scar color as measured by the erythema and melanin indices, whereas AFL was better for softening the scar.

Table 2. Machine values for erythema and melanin indices (EI & MI) as measured by the spectrophotometer and scar hardness as measured by the durometer

Value	**Fractional laser system**			
	NFL		**AFL**	
	Baseline	**Final**	**Baseline**	**Final**
Erythema index	24.47±3.59	23.00±3.50	24.09±3.12	23.48±3.06
p value*	**0.035**		0.327	
Melanin index	41.72±3.89	39.87±4.17	41.52±4.34	41.16±3.44
p value*	**0.003**		0.624	
Hardness	24.45±4.35	23.00±3.93	24.65±4.89	21.60±4.44
p value*	0.269		**0.026**	

Final = Final 3-month assessment

*Analysis by the Wilcoxon signed-rank test. Significance = $p<0.05$

3. Histologic changes

1) Hematoxylin & eosin stain (Figure 4)

Histologic tissue examination revealed increased collagen of dermis in postoperative scar before treatment (Figure 4A). After AFL treatment, epidermis was ablated. And microablative column (MAC), thermal coagulated zones and inflammations around MAC was observed one day after AFL treatment (Figure 4B). One week after AFL treatment, re-epithelialization was complete and microscopic epidermal necrotic debris (MEND) and thermally altered collagens were shown (Figure 4C). The granulation tissue and denatured collagen in upper dermis still remained in 1 month after AFL treatment (Figure 4D). One day after NAFL treatment, micronecrotic column (MNC) and MEND were shown (Figure 4E). Complete re-epithelialization and altered collagen were observed one week after NAFL treatment (Figure 4F). One month after NAFL, residually altered collagen was not observed (Figure 4G).

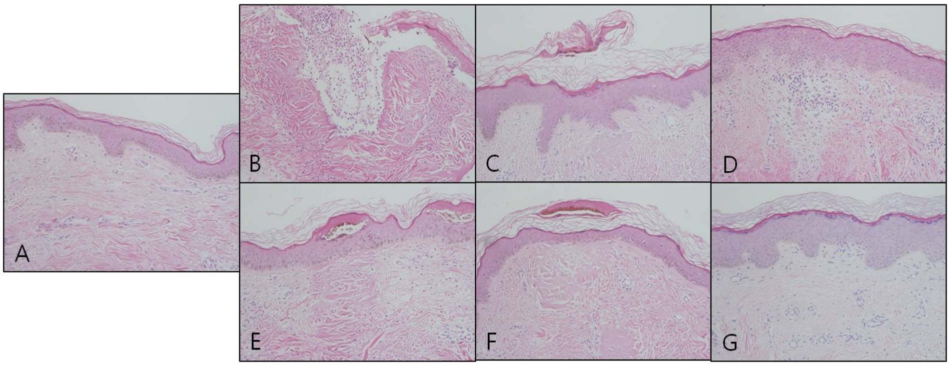

Figure 4. Histologic findings of scar before and after treatment using AFL and NAFL, Hematoxylin and eosin stain (x 200). (Before treatment (A), 1 day (B), 1 week (C) and 1 month (D) after AFL treatment; 1 day (E), 1 week (F) and 1 month (G) after NAFL treatment).

2) HSP 70 (Figure 5)

The pre-treated scar showed absent to minimal expression of HSP 70 (Figure 5A). At the AFL-treated site, the expressions of HSP 70 were strongly observed from 1 day after treatment and persisted until one month after treatment (Figure 5B-D). However, HSP 70 was mildly expressed one day after NAFL treatment and the degree of HSP 70 expression was increased one week after NAFL (Figure 5E-F). And strong expression of HSP 70 was observed one month after NAFL (Figure 5G).

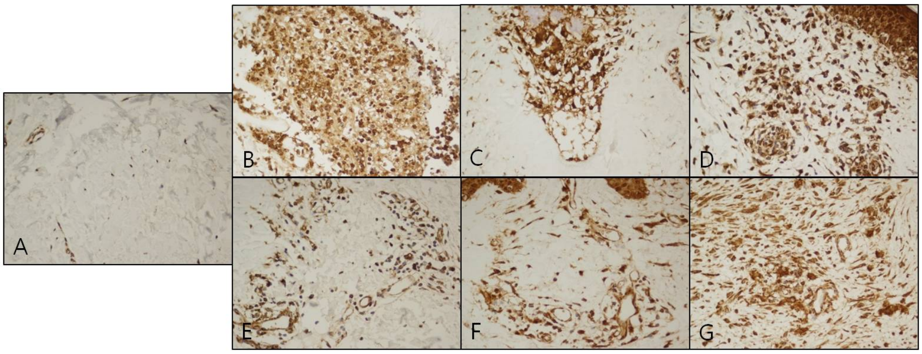

Figure 5. Histologic findings of scar before and after treatment using AFL and NAFL, HSP 70 stain (x 400). (Before treatment (A), 1 day (B), 1 week (C) and 1 month (D) after AFL treatment; 1 day (E), 1 week (F) and 1 month (G) after NAFL treatment).

3) TGF-β (Figure 6)

One day after AFL treatment, TGF-β was strongly expressed (Figure 6B) compared with no treated scar (Figure 6A). The degree of TGF-β was decreased until 1 month after treatment. However, the expression of TGF-β was mildly increased one day after NAFL and gradually increased until 1 month after treatment.

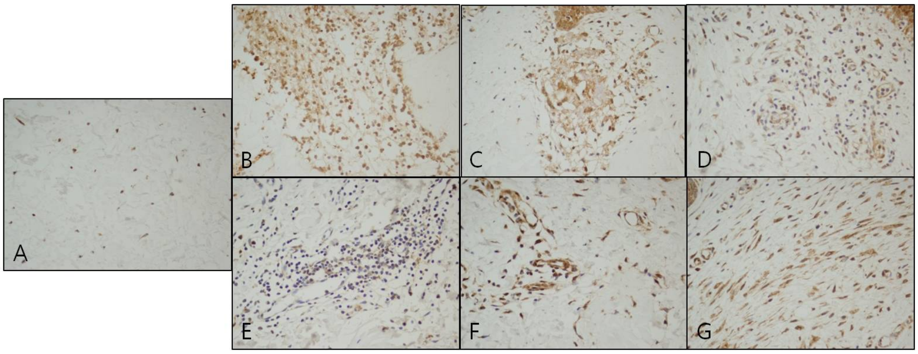

Figure 6. Histologic findings of scar before and after treatment using AFL and NAFL, TGF-β stain (x 400). (Before treatment (A), 1 day (B), 1 week (C) and 1 month (D) after AFL treatment; 1 day (E), 1 week (F) and 1 month (G) after NAFL treatment).

4) MMP-2 and MMP-9 (Figure 7 and 8)

The pre-treated scar showed absent to minimal expression of MMP-2 and 9 (Figure 7A and 8A). After AFL and NAFL, the expression of MMP-2 were gradually increased from 1 day after treatment to 1 month after treatment (Figure 7B-D and Figure 8B-D). In both treated sites, MMP-2 was expressed with similar intensity. On the AFL-treated site, MMP-9 was expressed strongly from 1 day after treatment and persisted until 1 month after treatment (Figure 7E-G). However, MMP-9 was expressed mildly on 1 day and 1 week after NAFL (Figure 8E-F). The expression of MMP-9 was increased 1 month after treatment. (Figure 8G).

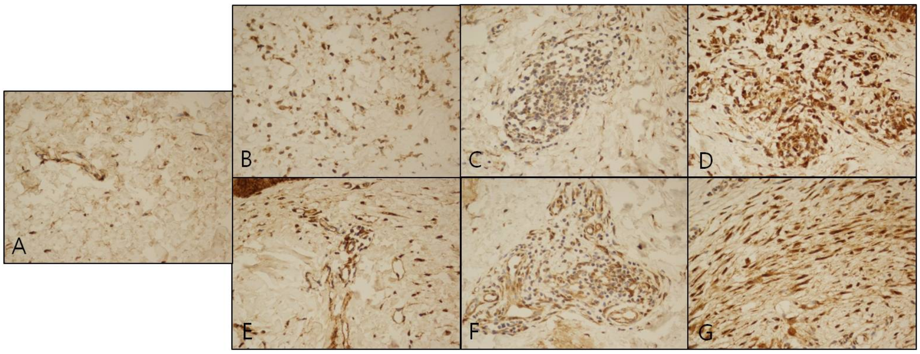

Figure 7. Histologic findings of scar before and after treatment using AFL and NAFL, MMP-2 stain (x 400). (Before treatment (A), 1 day (B), 1 week (C) and 1 month (D) after AFL treatment; 1 day (E), 1 week (F) and 1 month (G) after NAFL treatment).

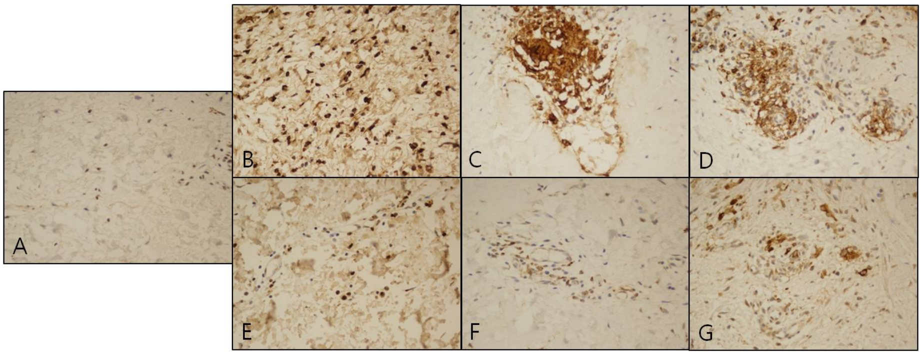

Figure 8. Histologic findings of the scar before and after treatment using AFL and NAFL, MMP-9 stain (x 400). (Before treatment (A), 1 day (B), 1 week (C) and 1 month (D) after AFL treatment; 1 day (E), 1 week (F) and 1 month (G) after NAFL treatment).

5) TIMP-1 & 2 (Figure 9 and 10)

Before treatment, TIMP-1 and 2 were not expressed in the scars (Figure 9A and 10A). After AFL, their expressions were minimally observed on 1 day (Figure 9B) and mildly increased 1 week after AFL treatment (Figure 9C). However, TIMP-1 and 2 were only observed during the 1 month follow-up on

NAFL-treated site (Figure 10G).

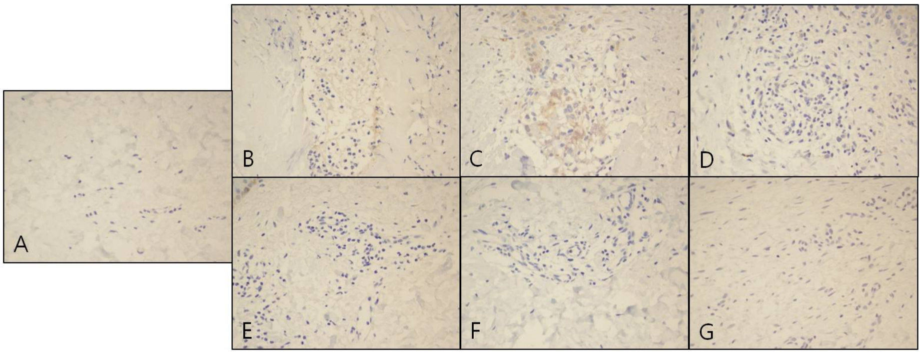

Figure 9. Histologic findings of the scar before and after treatment using AFL and NAFL, TIMP-1 stain (x 400). (Before treatment (A), 1 day (B), 1 week (C) and 1 month (D) after AFL treatment; 1 day (E), 1 week (F) and 1 month (G) after NAFL treatment).

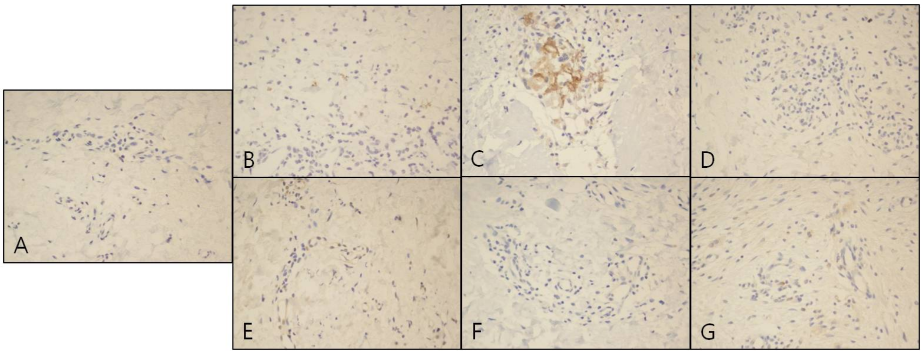

Figure 10. Histologic findings of the scar before and after treatment using AFL and NAFL, TIMP-2 stain (x 400). (Before treatment (A), 1 day (B), 1 week (C) and 1 month (D) after AFL treatment; 1 day (E), 1 week (F) and 1 month (G) after NAFL treatment).

4. Side effects

Mild hypertrophic scarring was seen in 2 patients. As it was limited to the center of the scar, this was believed to have been caused by allowing an overlap between the NFL and AFL treatments. Other than that, no adverse events were reported.

IV. DISCUSSION

The split-scar study with this small patient population (n=20) showed that there was no difference between NFL and AFL as for the clinical efficacy in the revision of mature post-thyroidectomy scars. This is interesting because the result with the AFL have been expected to be better, as the damage left in the tissue by each CO_2 AFL microbeam tends to be much deeper than for the Er:glass NFL. The NFL leaves a micronecrotic column (MNC) under an intact epidermis, compared with the microablative crater (MAC) left by the CO_2 microbeam, with damage to the epidermis as well as the dermis. With the deeper penetration associated with the MAC the crater might have been expected to extend down into the more dense fibrotic tissue layer which is the characteristic of scars, and potential better wound healing induction by the broader zone of residual thermal damage (RTD) could have been anticipated. The delivering of RTD was the holy grail of ablative resurfacing with the CO_2 and Er:YAG lasers and was known to encourage neocollagenesis in the proliferative phase resulting in well-organized new collagen fibers[10], which would certainly be noted at 3 months postoperation, when remodeling would be well under way in the present study. However, from the aspect of perceived clinical efficacy, this was not the case either for the clinician or for the patient assessment, at least, not at 3 months postop. Perhaps a better result might have been seen with a longer follow-up to allow remodeling to continue its particular task in the wound healing cycle.

Regarding scar hardness, on the other hand, the objective durometer findings pointed to a significant softening of the scar for the AFL-treated scars compared with those treated with NFL. This is most likely due to the above-expected phenomenon of deeper damage with better neocollagenesis replacing dense, fibrotic scar tissue in the deeper layers of the mature hypertrophic collagen.

The opposite was true for scar color, namely the EI and MI, which were significantly less for the NFL compared with the AFL, especially in the case of the MI (p=0.003). Perhaps the answer lies in the depth and extent of damage for both erythema and melanin formation, although they might have been expected to have evened off at the 3-month postop point. It is possible that the deeper damage and greater RTD associated with the AFL CO_2 beam created a more intense neovascularization in the deeper tissue, and this might have accounted for the machine-perceived 'redder' appearance of the AFL-treated scars, caused by light reflecting back off the network of new blood vessels. It is difficult to explain the highly significant difference in the MI, especially when the patient satisfaction index was almost the same for the AFL than the NFL, in fact 5% higher for the AFL-treated scarring. Had there been significant hyperpigmentation, patient satisfaction should have been low. This is perhaps the difference between the 'physical' value of color, as 'seen' by the spectrophotometer, and the 'natural' or 'artistic' value of color as seen by the naked eye. It is possible that the CO_2 macroablative columns generated more 'latent' melanin during healing due to the presence of secondary postinflammatory hyperpigmentation which was picked up by the photospectrometer but not by the naked eye.

Scar biopsies were performed both before and after treatment – at different time points – to thoroughly evaluate the different effects of AFL and NAFL. AFL and NAFL may affect scars differently through the stimulation of cytokines, HSPs, MMPs and TIMPs[11,12] and we evaluated the expression of HSP 70, TGF- β, MMP-2, MMP-9, TIMP-1 and TIMP-2 after AFL and NAFL treatment. HSP 70 is an important mediator of laser-assisted remodeling and tends to be up-regulated after thermal damage.[13,14] And HSP 70 can induce synthesis of transforming growth factor β (TGF-β) that is important in scar remodeling.[15,16] In our study, HSP 70 and TGF-β were expressed in an earlier and stronger manner in AFL treated sites compared to the NAFL treated sites. TGF-β modulates MMPs and TIMPs that regulate extracellular matrix. In the skin, MMPs and TIMPs are temporarily induced by exogenous stimuli, not constitutively expressed and skin.[17] After AFL and NAFL treatment, MMP-2 was similarly expressed in both laser-treated sites with tendency to increase overtime. However, the expression of MMP-9 of the AFL-treated site was observed earlier and with greater magnitude than that of the NAFL-treated site, similar to HSP 70 and TGF- β. TIMP-1 and TIMP-2 were expressed early stage after AFL and late stage after NAFL. These differences in expressions of HSP 70, TGF- β, MMP-2, MMP-9, TIMP-1 and TIMP-2 after AFL and NAFL treatment may explain the differences in clinical effects between the two types of lasers. In our study, we evaluated these changes in only a few patients within a period of 1 month. In the future, immunohistochemical studies and molecular genetic testing would be needed involving more patients for a substantially longer period of time to elucidate the mechanism of treatment in the two lasers.

Normally in studies where clinician and patient satisfaction are compared, following for example a skin rejuvenation study, the clinician assessments are very often better than the patient assessments, the latter being more critical of the results perhaps due to the fact that they are not comparing the baseline with the final ‘picture in the mirror’ whereas the clinicians are looking at side-by-side clinical photographs. In the present study on the other hand, subjective patient satisfaction was higher than the clinician efficacy ratings, an interesting reversal of the normal pattern. The softer aspect of the scar may have had something to do with this.

V. CONCLUSION

Based on this 20-subject split-scar study on the use of NFL and AFL for c post-thyroidectomy scars, no significant difference was seen in clinical efficacy between the two approaches, either by the clinicians or by the patients themselves. NFL was shown to be significantly superior for removing color from the scar, whereas AFL made the scars significantly softer. On the other hand, patient satisfaction was almost equally high for both modalities. The findings suggest that a combination approach, whereby the more superficial NFL is followed by the deeper-acting AFL, might have interesting results in the revision of post-thyroidectomy scars, and a future controlled study designed around that premise would be merited.

REFERENCES

1. Rafferty M, Miller I, Timon C. Minimal incision for open thyroidectomy. Otolaryngol Head Neck Surg 2006;135:295-8.
2. Niwa AB, Mello AP, Torezan LA, Osório N. Fractional photothermolysis for the treatment of hypertrophic scars: clinical experience of eight cases. Dermatol Surg. 2009;35:773-7.
3. Behroozan DS, Goldberg LH, Dai T, Geronemus RG, Friedman PM. Fractional photothermolysis for the treatment of surgical scars: a case report. J Cosmet Laser Ther. 2006;8:35-8.
4. Tierney E, Mahmoud B, Srivastava D, Ozog D, Kouba DJ. Treatment of surgical scars with fractional photothermolysis versus pulse dye laser: randomized control trial. Dermatol Surg. 2009;35:1172-80.
5. Chapas AM, Brightman L, Sukal S, Hale E, Daniel D, Bermstein LJ, Geronemus RG. Successful treatment of acneiform scarring with CO2 ablative fractional resurfacing. Lasers Surg Med. 2008;40: 381-6.
6. Cho SB, Lee SJ, Kang JM, Kim YK, Chung WS, Oh SH. The efficacy and safety of 10,600-nm carbon dioxide fractional laser for acne scars in Asian patients. Dermatol Surg. 2009;35: 1955-61.
7. Tierney EP, Hanke CW. Ablative fractionated CO2, laser resurfacing for the neck: prospective study and review of the literature. J Drugs Dermatol. 2009;8: 723-31.
8. Choe JH, Park Y, Kim B, et al. Prevention of thyroidectomy scar using a new 1,550-nm fractional erbium-glass laser. Dermatol Surg 2009;35:1-7.
9. Jung JJ, Jeong JJ, Roh HJ, Cho SH, Chung KY, et al. Early postoperative treatment of thyroidectomy scars using a fractional carbon dioxide laser. Dermatol Surg 2010; [Epub ahead of print]

10. Trelles MA, Allones I, Luna R. One-pass resurfacing with a combined-mode erbium: YAG/CO2 laser system: a study in 102 patients. Br J Dermatol. 2002;146: 473-80.

11. Kuo YR, Wu WS, Jeng SF, Wang FS, Huang HC, Lin CZ, Yang KD. Suppressed TGF-beta1 expression is correlated with up-regulation of matrix metalloproteinase-13 in keloid regression after flashlamp pulsed-dye laser treatment. Lasers Surg Med 2005;36:38-42.

12. Ulrich D, Ulrich F, Unglaub F, Piatkowski A, Pallua N. Matrix metalloproteinases and tissue inhibitors of metalloproteinases in patients with different types of scars and keloids. J Plast Reconstr Aesthet Surg 2009;21: [Epub ahead of print]

13. O'Connell-Rodwell CE, Mackanos MA, Simanovskii D, Cao YA, Bachmann MH, Schwettman HA, Contag CH. In vivo analysis of heat-shock-protein-70 induction following pulsed laser irradiation in a transgenic reporter mouse. J Biomed Opt 2008;13:030501.

14. Wilmink GJ, Opalenik SR, Beckham JT, Davidson JM and Jansen ED. 10 Assessing laser-tissue damage with bioluminescent imaging. J Biomed Opt 2006;11:041114.

15. Munger JS, Huang X, Kawakatsu H, Griffiths MJ, Dalton SL, Wu J, Pittet JF, Kaminski N, Garat C, Matthay MA, Rifkin DB, Sheppard D. The integrin alpha v beta 6 binds and activates latent TGF beta 1: a mechanism for regulating pulmonary inflammation and fibrosis. Cell 1999;96:319-28.

16. Arany PR, Nayak RS, Hallikerimath S, Limaye AM, Kale AD, Kondaiah P. Activation of latent TGF-beta1 by low-power laser in vitro correlates with increased TGF-beta1 levels in laser enhanced oral wound healing. Wound Repair Regen 2007;15:866-74.

17. Kähäri VM, Saarialho-Kere U. Matrix metalloproteinases in skin. Exp Dermatol 1997;6:199-213.

Abstract (in Korean)

수술 후 흉터에서 비박피성 및 박피성 fractional laser 치료 효과의 비교

<지도교수 이주희>

연세대학교 대학원 의학과

Dorjsuren Gantsetseg

갑상선 절제 수술 후에 나타나는 수술 흉터는 환자뿐만 아니라 의사에게도 큰 문제가 된다. 이에 따라 최근 비박피성 fractional laser (Non-ablative fractional laser, NFL) 과 박피성 fractional laser(Ablative fractional laser, AFL)이 각각 수술 후의 흉터 치료를 위한 훌륭한 도구로 각광을 받고 있다. 본 연구에서 시행한 흉터 내 분리 비교 연구는 갑상선 수술 흉터의 치료에 있어 두 가지 레이저 시스템의 효과를 비교하기 위해 설계 되었다.

갑상선 절제 수술 후 2-3개월이 지난 흉터를 가지고 있는 20명의 여자 환자 (22-55세, 평균 42.1세)가 연구 대상으로 모집되었다. 이들 환자에서 흉터를 절반으로 나누어 한쪽은 NFL (MOSAIC™, Lutronic, Ilsan, Korea)로, 그리고 다른 한쪽은 AFL(eCO2™, Lutronic, Ilsan, Korea)로 각각 치료 하였으며, 이 때 어떤 레이저로 어떤 부위를 치료할 것인지는 무작위로 결정되었다. 환자들에게는 총 2회의 치료가 시행되었으며, 치료 간격은 2달로 유지하였다. 모든 환자들은 첫 번째 방문 시와 각각의 치료 전, 그리고 마지막 치료 후 3개월이 지난 시점에서 임상 사진을 찍었으며, 이 시점에서 두 명의 독립된 피부과 의사가 임상 사진을 분석하여 4 단계로 호전도를 평가하였고 환자 스스로도 4 단계로 만족도를 평가 하였다. 첫 방문 시에는 dermaspectrometer와 durometer를 이용하여 피부의 색조 (홍반(EI)과 멜라닌 지수(MI))와 피부의 경도 또한 각각 측정 하였다. 의사에 의한 평가 결과, 7명의 환자에서 AFL이 NFL보다 효과가 좋은 것으로

나타났고, 6명의 환자에서는 NFL이 AFL보다 효과가 좋은 것으로 나타났으며, 7명에서는 두 레이저의 효과가 비슷한 것으로 평가되었다. 환자 자신에 의한 평가 결과로는 6명에서 AFL이, 5명에서 NFL이 효과가 우세한 것으로 평가되었고, 9명에서는 두 레이저의 효과가 비슷한 것으로 평가 되었다. 의사에 의한 호전도 평가의 평균은 AFL과 NFL에서 각각 2.45±0.99와 2.35±0.85로 나타났으며, 통계적으로 유의한 차이는 보이지 않았다(p=0.752). 14명의 환자가 AFL의 치료 효과에 대하여 매우 만족, 혹은 만족한다는 평가를 하였고, NFL에 대해서는 13명의 환자가 이와 같은 평가를 하였으며, 2명의 환자들은 두 가지 치료 모두에 대하여 불만족 한다는 반응을 보였다. EI와 MI는 NFL에서 모두 통계학적으로 유의하게 좋은 것으로 나타났고 (각각 p=0.035, p=0.003), 피부의 경도는 AFL에서 약간 좋은 것으로 나타났다 (p=0.026). 2명의 환자에서는 경미한 비후성 반흔이 관찰되었다.

갑상선 절제수술 후의 흉터에 대한 치료 효과를 비교했을 때 두 가지 레이저 시스템의 치료 효과는 임상적으로 유의하게 다르지 않았다. 하지만, 흉터의 경도 측면에서 보았을 때는 AFL이 우세하였으며, 색조의 측면에서 평가했을 때는 NFL이 우세한 것으로 나타났다. 이러한 결과는 갑상선 절제수술 후 흉터 치료에 있어 두 가지 레이저를 병합한 치료 방법이 좋은 효과를 나타낼 수 있음을 시사한다고 할 수 있다.

핵심되는 말: 흉터치료, 비후성 반흔, fractional laser technology, 멜라닌 지수, 홍반 지수