Laser hair removal affects sebaceous glands and sebum excretion: A pilot study

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Background: During laser-assisted hair removal, sebaceous glands closely associated with hair follicles might also be affected.

Objective: We investigated the effect of the long-pulsed ruby laser on sebaceous glands.

Methods: Sebum excretion rates (SERs) of 16 subjects were measured quantitatively by means of sebum-absorbent tape and analyzed by means of image analysis techniques on laser-treated sites, compared with adjacent untreated areas. Evaluation was done at an average of 9 months (range, 4.5 to 12 months) after the last treatment. Histologic examinations were performed on 3 representative subjects before treatment, immediately after treatment, and 9 months after the last treatment.

Results: Significant increases in SERs were observed in 11 of 16 subjects (68.75%). Three subjects (18.75%) showed lower SERs, whereas 2 subjects (12.5%) demonstrated no difference in SERs between treated and untreated areas. Biopsy specimens showed an apparent reduction in sebaceous gland size. Specimens taken immediately after laser irradiation revealed sporadic damage to sebaceous glands.

Conclusion: In some patients a variable but statistically significant increase in sebum excretion occurs 4 to 12 months after ruby-laser hair removal treatment at high fluences. A reduction in sebaceous gland sizes on laser-treated areas was observed. We hypothesize that decreased resistance to sebum outflow may explain this result, following miniaturization or absence of hair shaft after ruby laser treatment. Further study is needed to assess mechanisms for this interesting response. (J Am Acad Dermatol 1999; 41:176-80.)

The recent introduction of lasers and nonlaser light pulses for removal of pigmented, terminal hair has raised interest and expectation among both physicians and patients.[1-4] Most of these hair removal systems have been designed to cause selective photothermal damage to pigmented hair follicles. However, sebaceous glands are intimately associated with hair follicles in the pilosebaceous units, and may be injured or secondarily affected by laser hair removal. The long-pulsed ruby laser has been used for hair removal since 1996 and may cause permanent hair removal in some patients.[1,5] In this study, we investigated the long-term effects of long-pulsed ruby hair removal lasers (0.3 and 3 msec) on sebaceous glands by examining sebum output and histologic features compared with adjacent untreated sites on the back or thigh.

METHODS

Subjects and lasers

The study was performed on 16 subjects (14 males and 2 females; age, 40.3 ± 8.1 years, mean ± SD) randomly selected from a group of 50 patients who participated in a study of long pulsed ruby laser (0.3 and 3 msec pulsewidths; 60 msec delay between pulses; Spectrum Medical, Lexington, Mass) for hair removal, by means of pulse fluence ranging from 30 to 50 J/cm^2 delivered in 7-mm diameter adjacent uniform spots.

Sebum output was measured on sites given 2 laser

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Accepted for publication March 5, 1999.

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0190-9622/99/$8.00 + 0 **16/1/98289**

Table I. Patient characteristics

No. of patients	Age (y)	Average fluence (J/cm²)	Pulse width (msec)	Collection period (mo after second treatment)	Treatment sites	Sebum output (nl/cm²)		Effects on SERs
						Untreated control	Laser treated	
1	52	41	0.3	12	Back	4.02	3.82	↓
2	40	48	0.3	9	Back	6.04	13.13	↑
3	44	48	0.3	10	Back	0.05	2.76	↑
4	45	36	0.3	9	Thigh	0.06	3.14	↑
5	50	50	0.3	10.5	Back	0.20	0.20	≈
6	36	43	0.3	8	Back	0.21	2.96	↑
7	47	41	0.3	10	Thigh	0.01	0.01	≈
8	29	40	0.3	11	Back	7.12	3.76	↓
9	40	42	0.3	9	Thigh	0.02	0.41	↑
10	47	44	3.0	8	Back	4.25	6.07	↑
11	50	45	3.0	8	Thigh	0.00	0.04	↑
12	36	44	3.0	8	Thigh	0.35	0.19	↓
13	30	45	3.0	6	Back	3.53	11.27	↑
14	34	48	3.0	8	Thigh	0.02	0.10	↑
15	25	38	3.0	4.5	Thigh	0.35	0.52	↑
16	40	30	3.0	8	Back	10.12	17.05	↑

↓, Decreased SER; ↑ increased SER; ≈ No alterations in SER.

treatments with double-pulsing, at fluence ranging from 36 to 50 J/cm². The evaluation period ranged from 4.5 to 12 months (average 9 months) after the second treatment. Nine patients (age, 42.6 ± 7.2 years) were treated with a 0.3-msec pulsewidth laser whereas the others (aged 37.4 ± 8.9) were treated with a 3 msec pulsewidth laser. Treated areas included 9 backs and 7 thighs.

Measurement of sebum production

Sebum excretion rates (SERs) were measured quantitatively by means of sebum-absorbent tapes (Sebutapes, CuDerm Corp, Dallas, Tex) and image analysis technique. Sebutapes are white, open-celled, microporous, hydrophobic films coated with an adhesive layer that adheres to the skin surface. As sebum issues from the follicular opening, it is absorbed into the tape. As the air within the microcavities is displaced by sebum, the lipid-filled cavities become transparent. The area occupied by transparent spots per square centimeter is a convenient and reproducible measure of sebum production.[6,7]

Before application of Sebutapes, the skin was shaved, cleaned, and defatted by gentle wiping for 15 seconds with 70% isopropyl alcohol preparation. When the skin was dry, the tapes were affixed with slight pressure to 2 sampling sites on each patient for 1 hour. One sampling site was the laser-treated site and the other was a control sampled from an adjacent untreated area. After removal, the tapes were placed on a plastic transparent sheet and were evaluated by image analysis as previously described.[8]

Histologic examination

Punch biopsy specimens (4 mm) were taken from the untreated control and laser-treated sites in 3 patients. Specimens were stained with hematoxylin and eosin. A series of cross-sectioned specimens beginning from the infundibular through suprabulbar levels were examined to identify the histologic characteristics of the sebaceous structures in the untreated versus laser-treated areas. The maximum diameter of sebaceous glands in the pretreatment and posttreatment skin was also measured at the infundibulum, isthmus, and suprabulbar levels.

Hair counts and diameters

The number and the average diameter of terminal hairs present at 9-month follow-up after the last treatment were compared with the baseline hair counts and hair diameters. Hair counts were performed manually from images taken from a CCD camera (Pulnix, Japan) using identical lighting, camera, and anatomic positions marked by tattooing. Average hair shaft diameters were measured from 6 hair samples of each subject taken from the sites before and 9 months after treatment by means of a microscope coupled to a CCD camera for display; shaft diameter was then measured with NIH image analysis software on a Macintosh computer.

Statistical analysis

Statistical significance of the sebum excretion data was evaluated by the Wilcoxon sign rank tests. Mean differences were considered to be significant when the value of P was less than .05.

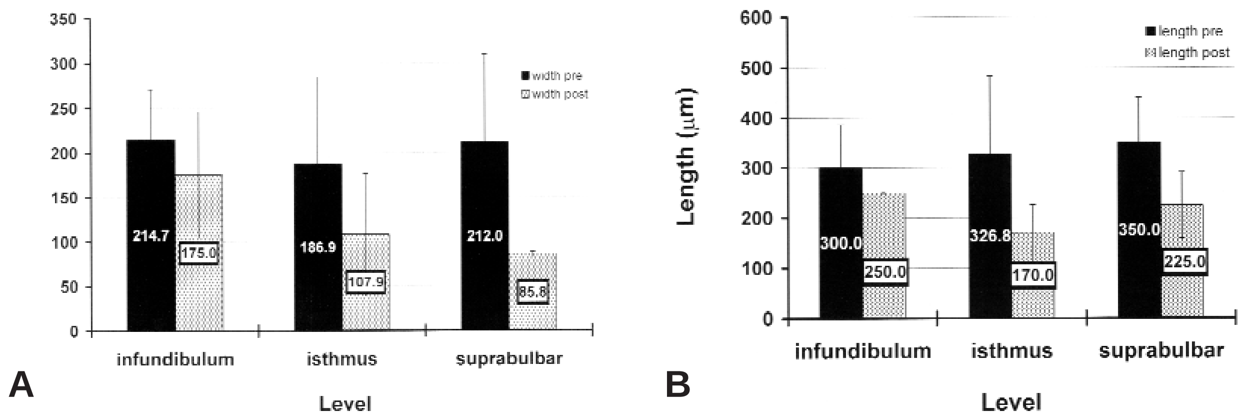

Fig 1. Sebaceous gland measurements, pretreatment and 9-month posttreatment. **A,** Sebaceous gland width (y-axis, in micrometers). **B,** Sebaceous gland length. *Bars* indicate standard deviation.

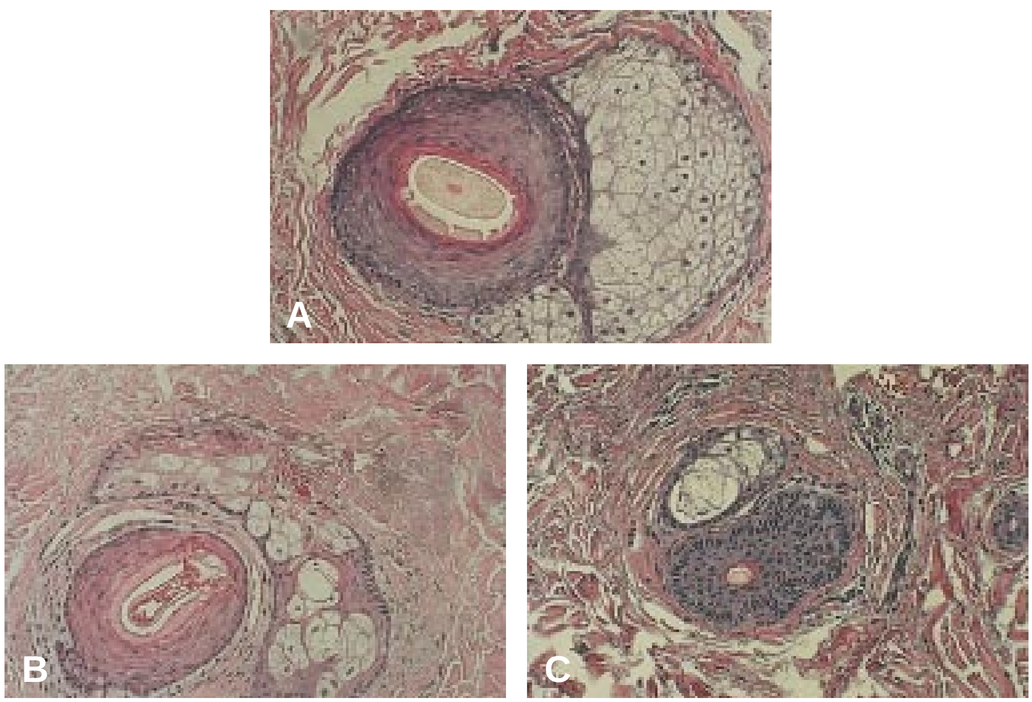

Fig 2. Photomicrographs of biopsy specimens show sebaceous glands at isthmus level. **A,** Before treatment. **B,** Immediately after laser irradiation. There is focal damage to sebaceous glands. **C,** 1 year after second laser treatment.

RESULTS

Sebum output

There was a significant (P = .035) increase in SERs in laser-treated versus adjacent untreated skin. Eleven subjects (68.75%) had higher SERs on the treated sites. Three subjects (18.75%) showed lower SERs on the treated sites, and 2 subjects (12.5%) demonstrated no difference in SERs between treated and untreated areas (Table I). No clinical evidence of skin alterations was observed on the laser-treated areas in any subject. Pulse-width (0.3 and 3 msec) and anatomic site had no apparent effects on the results.

Histologic findings

A decrease in glandular size was observed at all 3 anatomic levels of sebaceous glands (significantly at isthmus parts) in 3 representative subjects (Figs 1 and 2). Sporadic damage to sebaceous glands was noted immediately after laser irradiation (Fig 2, *B*). No other morphologic alterations in sebaceous glands were observed in the laser-treated skin.

Hair counts and average diameters

The laser-treated areas showed significant hair loss ($P < .001$) compared with baseline. Hair diameters were significantly smaller ($P = .021$) after laser treatments. However, there was no correlation between the percentage of hair regrowth, hair diameter before and after treatment, and proportion of SERs in untreated and laser-treated areas.

DISCUSSION

Selective damage to pigmented hair follicles by normal-mode ruby laser pulses[1] is consistent with the theory of selective photothermolysis.[9] Although it is clear that pigmented, terminal hair regrowth can be delayed or inhibited, the potential effects on sebaceous glands associated with hair follicles remain unknown. In this study, we demonstrated an increase in sebum excretion and an apparent decrease in sebaceous gland size 9 months after ruby laser treatment. At first this seems paradoxical—how can smaller sebaceous glands produce greater sebum output? Human sebaceous glands contain no pigmented melanocytes.[10] The 694 nm ruby laser wavelength is very poorly absorbed by sebaceous glands, such that primary thermal effects are unlikely. We hypothesize that decreased resistance to sebum outflow may explain the results, following miniaturization or absence of hair shafts after ruby laser treatment. Increased sebocyte proliferation has been reported after injury to the superficial portion of pilosebaceous follicles, and after epidermal growth factor stimulation.[11,12] We noted focal injury of the sebaceous glands histologically, immediately after laser treatment.

It is therefore possible that laser-induced injury stimulated the sebaceous glands. However, a proliferation response to injury is not consistent with reduction of sebaceous gland size. In contrast, decreased resistance to sebum outflow would reasonably decrease the pressure and hence the size of sebaceous glands while increasing sebum output.

Interestingly, some of our patients who underwent facial hair removal by means of long-pulsed ruby laser have reported improvement of acne after the procedure. Although the acne-like lesions of pseudofolliculitis barbae may explain this anecdotal clinical observation, it is also possible that altered sebum excretion is involved. The pathogenesis of acne is multifactorial.[13] Resistance to sebum outflow is a secondary mechanism that may cause sebum retention, bacterial colonization, and clinical acne.[14] For example, Cunliffe et al[15] observed that the severity of acne inversely relates to pilosebaceous canal exit size. After ruby laser treatment, the loss or decrease in terminal hair may reduce mechanical obstruction of sebum outflow, accounting for increased SER and potentially for improvement of acne. Until proven in a controlled prospective study, however, there is no firm evidence that laser treatment reduces acne.

In conclusion, an increase in sebum excretion rate occurs in some patients and persists for up to 12 months after ruby laser hair removal treatment at high fluences. Histologically, there was an apparent decrease in sebaceous gland size. Decreased resistance to sebum outflow as a result of miniaturization or absence of hair shafts after ruby laser treatment may explain this result.

We thank William Farinelli and Anastasia Drohan for their technical assistance.

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