

# Laser-Assisted Suction of Axillary Sweat Glands and Axillary Epilation

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## 77.1

### Introduction

Axillary hyperhidrosis (sweating) commonly causes discomfort and unpleasant body odor, both of which can lead patients to feel socially handicapped. Current treatment options for this condition leave much room for improvement:

- Conservative treatment with drugs is in most cases unsatisfactory.
- Botox therapy is expensive and only helps for a few months.
- Endoscopic transthoracic sympathectomy bears considerable risks.
- Suction in tumescent anesthesia with a blunt cannula alone is less successful than Botox treatment.

Therefore we set out to find a better treatment for this condition. The general approach tested here was to combine suction treatment with subdermal Nd:YAG or diode laser application in tumescent anesthesia.

All patients agreed to be part of this clinical study, were informed about alternative treatment options, and signed an informed consent form. All surgeries were performed on an ambulatory basis.

## 77.2

### Patients

All patients included in this study ( $n=64$ , 36 women, 28 men) had been suffering from hyperhidrosis axillaris for years. All had tried sprays, powders and other conservative options. In most cases, hyperhidrosis began during adolescence, although in some patients the onset was in the early twenties. A total of 154 axillae were treated because some patients with recurrence in 2002 and 2003 had to be treated up to three times. The age of our patients varied between 19 and 61 years with a clear peak in the late twenties.

## 77.3

### Method

Two preoperative appointments for oral and written consent and a sweat test were mandatory. If there were significant medical risk factors a checkup by a general physician was required. Contraindications were similar to the ones for liposuction. An intravenous line or sedation (midazolam) was only necessary in very sensitive individuals and was not routinely administered. It should be noted that both the patient and the surgeon must wear protective glasses during laser treatment!

Axillary hair should not be shaved. We start with a second simple sweat test (iodine/starch) because sweat production may vary (Fig. 77.1).

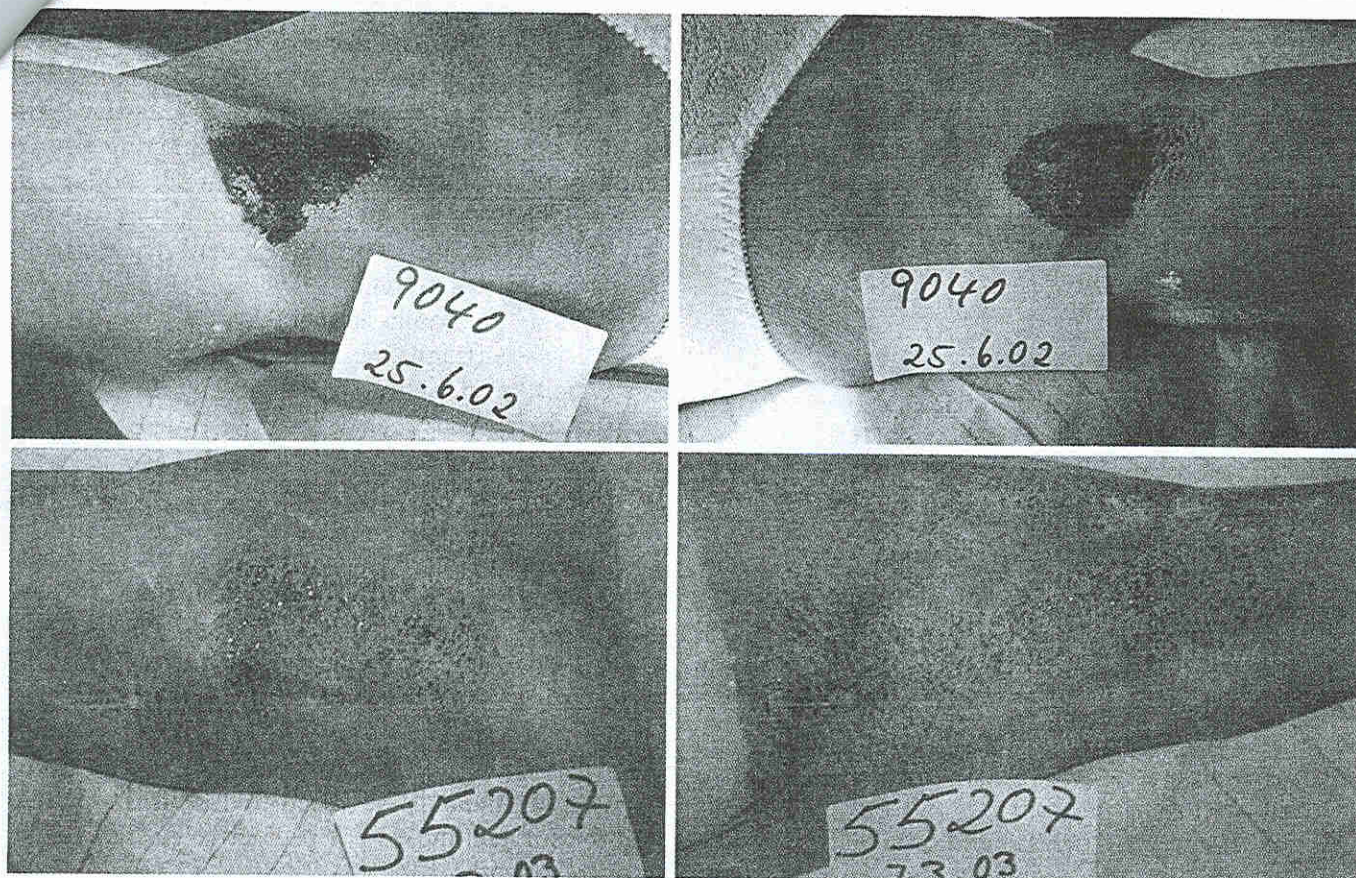
Significant differences in the size of sweat-producing areas were observed in different patients. One patient may produce high amounts of sweat in an area of around  $8 \text{ cm}^2$ , whereas another patient may produce the same amount of sweat in an area of  $50 \text{ cm}^2$ . A remarkable number of patients had less sweat production after the second preoperative talk in comparison with the test just before surgery. This emphasizes how significant the psychological component of unwanted sweating can be.

The area of concern and an additional 5 cm in diameter around the hairy zone is marked with iodine solution (spray) and dried with a hair dryer. Powdering with corn starch follows. Areas of active sweat production turn black and are outlined with a marker pen (Fig. 77.2).

After surgical disinfection of the skin and sterile draping, Klein's solution is infiltrated at about 200–350 ml per axilla with an infiltration pump. There is no need for deep infiltration. The goal of infiltration is anesthesia, firmness of the tissue and constriction of the vessels to prevent hematoma; however, care must be taken to avoid unwanted deep infiltration, as this may provoke a plexus anesthesia of the arms and hands (Fig. 77.3).

Subdermal dissection is performed with a blunt Blugerman spatula. The tip of the cannula is always directed towards the skin (Fig. 77.4).

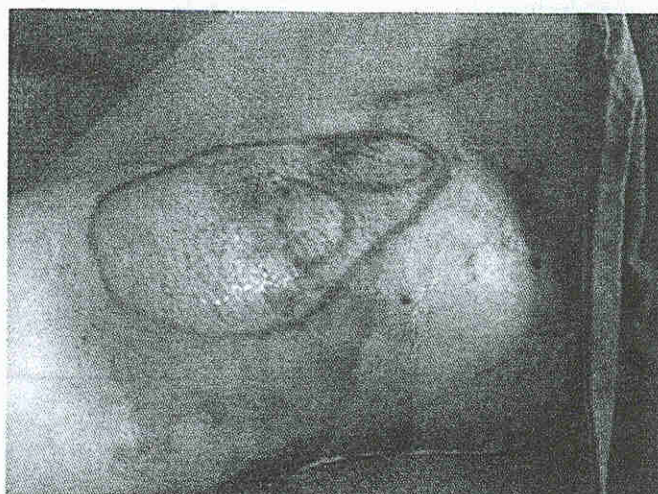




**Fig. 77.1.** Different patterns of sweat gland distribution. Concentration of sweat glands (*upper*). The scattered type of alignment (*lower*) (iodine/starch test)



**Fig. 77.2.** Painting the axilla with iodine solution should be done generously so as not to miss ectopic sweat glands



**Fig. 77.3.** Infiltration of the axilla with Klein's solution. Pronounced tumescence is necessary for laser treatment and suction

From our past experience, plain suction of sweat glands in tumescent anesthesia alone with a blunt common cannula is definitely not an optimal solution. Although plenty of suctioned sweat glands can be found in the aspirate after suction with a blunt cannula, clinical experience and follow-up analysis tells a different story. Even though patients might be happy with the outcome for a few weeks, only a very small reduction of sweat

production in sweat tests was seen in these patients several months after surgery with a blunt cannula.

Progress could be achieved by means of a Becker tip cannula with a rough configuration of the edges of the aspiration holes. This type of cannula serves to nick and "rasp" the subdermis in a manner that exposes both sweat glands and hair follicles to the laser treatment that follows suction (Fig. 77.5).



When should rasping of the subdermis be stopped? After subdermal dissection with the blunt Blugerman spatula a thin layer of subdermal fat remains. During suction two fingertips should always be positioned aside the tip of the cannula following the crisscrossing movement from all stab incisions. The skin becomes thinner and thinner. Stop when you feel the rough edges of the aspiration opening of the cannula in between your fingertips.

Afterwards the laser fiber (0.6 mm in diameter) is introduced into a 2-mm infiltration cannula whose tip was cut and fixed by a fiber lock at the proximal end of the handpiece. It is imperative that the tip of the fiber protrudes from the end of the cannula by 2 mm (Figs. 77.6, 77.7).

Should the tip of the fiber slip back into the open end of the cannula, this can lead to intense heat development, which in turn can burn both the fiber and the cannula. Should this occur, bright flashes can be observed under the skin and the laser must be switched off immediately to reposition the tip of the fiber for

reasons of safety. Otherwise overheating can occur without any of the desired effect on the sweat glands or hair follicles. This can happen quite often, mainly in cases of recurrence with fibrotic subdermis.

Stab incisions are left open for drainage and are covered with sterile swap pads. The stab incisions are

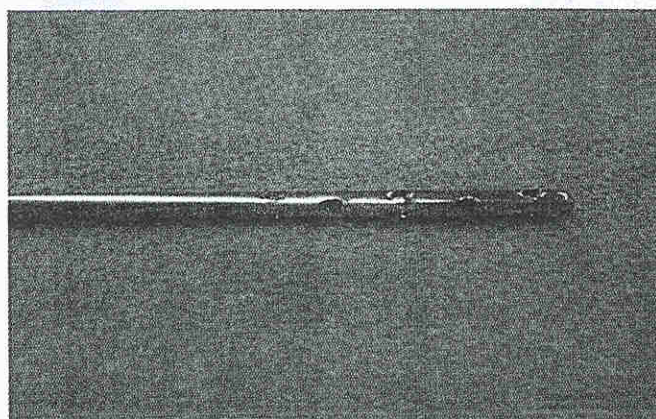


Fig. 77.5. Becker tip cannula with rough suction holes



Fig. 77.4. Dissecting the skin from the subcutaneous tissue with a blunt spatula. Blugerman dissection spatula (*inset*)

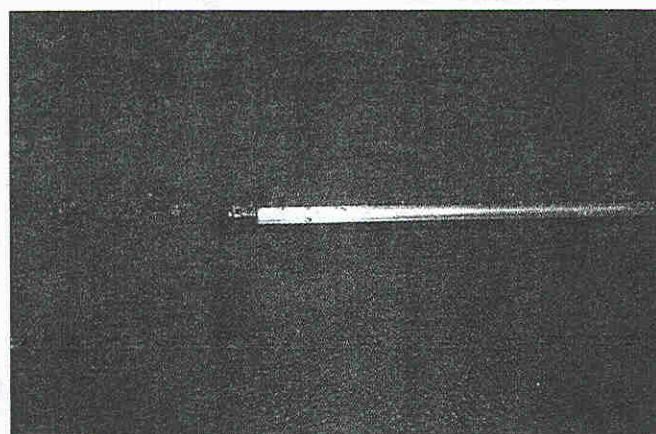


Fig. 77.6. Laser fiber protected in a 2-mm infiltration cannula with cut tip

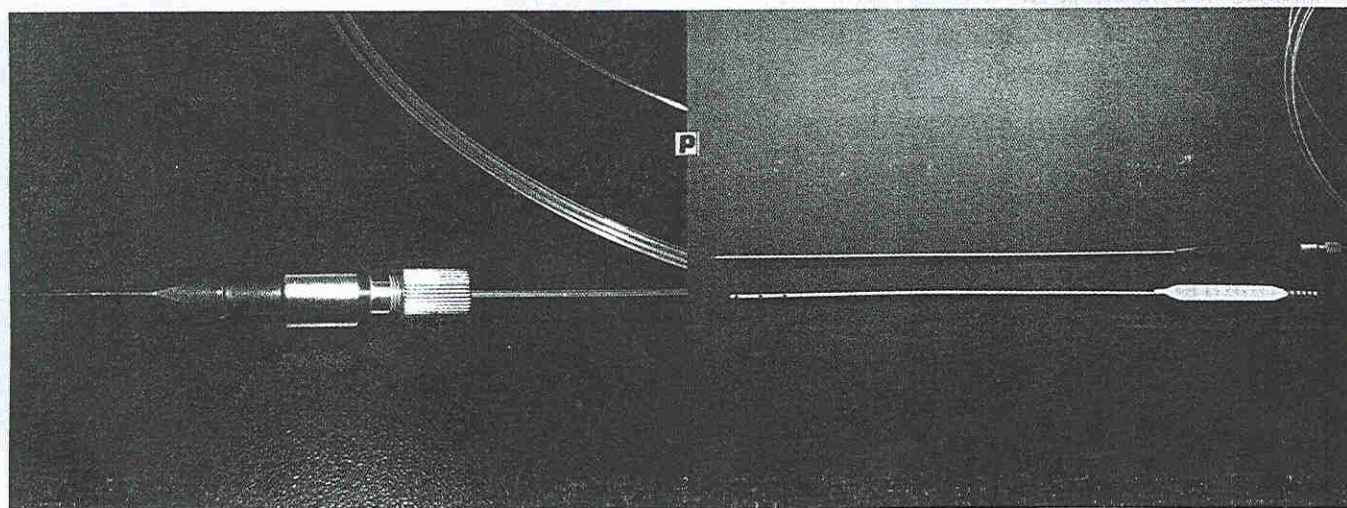


Fig. 77.7. Fiber lock at the proximal end of the infiltration cannula and both cannulas in total view



closed 2 days postoperatively with waterproof suture strips to allow showering.

Clinical examination as a routine is arranged after 2 days, 1 week, 3 months and 6 months or at any time in the case of trouble.

## 77.4

### Objective for Laser Treatment

Sweat glands and hair follicles are situated in the deep dermal layer (Fig. 77.8). As epilation from "outside" is possible, why not apply a Nd:YAG or a diode laser from underneath to destroy both sweat glands and hair follicles?

Our objective is a direct approach for removal of both sweat glands and hair follicles. We started applying 6 W at 10 Hz and an impulse width of 20 ms with an cumulative energy of about 0.5 kJ per axilla. The tip of the cannula was elevated against the surface of the skin from underneath at an angle of about 20–30° and moved around in a crisscrossing manner from at least two—better three—stab incisions (Figs. 77.9, 77.10).

Subsequently we increased the applied energy in increments of 5 W. In every case we took a punch biopsy from each side. Later we took the second specimen 10 days after surgery or later and noted a much more intense destruction of our targets, since histologic manifestation of damage needs time to become visible in sections.

Up to 40 W with an impulse width of 20 ms was applied. The maximum total energy applied per axilla was 7.8 kJ in this phase and the first partial dermal necrosis was observed at 450 J/cm<sup>2</sup> on the right side and at 525 J/cm<sup>2</sup> on the left side in very small axillae. Because of temporary loss of sensitivity the patient did not suffer from pain (Fig. 77.11).

This damage was treated for 4 weeks without further complications or complaints.

Because of the massive rise in skin temperature above 30 W of laser power we introduced a skin-cooling device to prevent further skin damage (Fig. 77.12).

## 77.5

### Laser Treatment and Suction or Laser Treatment Alone? Which Approach is Superior?

For a few months in 2003 we studied two groups of patients. Group 1 received laser treatment plus suction; group 2 received laser treatment alone. Specification of the data is in Tables 77.1–77.4 and Figs. 77.13–77.15.

There is no doubt that the combination of suction and laser bears fewer risks, is more comfortable for

the patient and renders better results. We stopped laser treatment without suction immediately after evaluating the results of the treatment of the two groups (the data were published at the AACS meeting in St. Louis, 2004).

## 77.6

### Safety Measures

- Air cooled to 5°C was applied from a distance of about 25 cm to prevent damage to the skin.

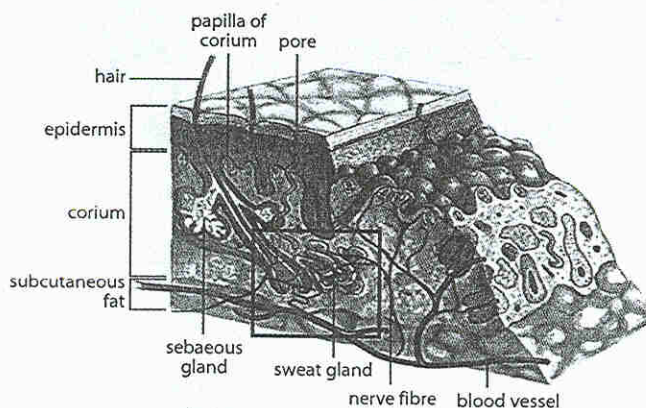


Fig. 77.8. Where is the target of the treatment of hyperhidrosis? The position of the sweat glands and the hair follicles is located in the deep dermis

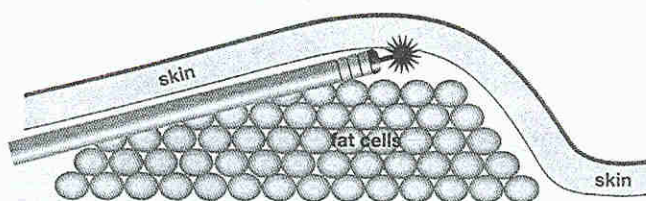


Fig. 77.9. Bare fiber in subdermal position. The tip of the hand piece is elevated, and the skin is struck at an angle of about 30°

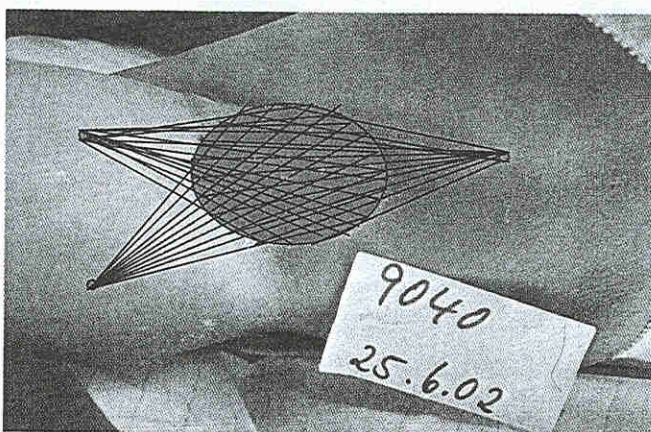
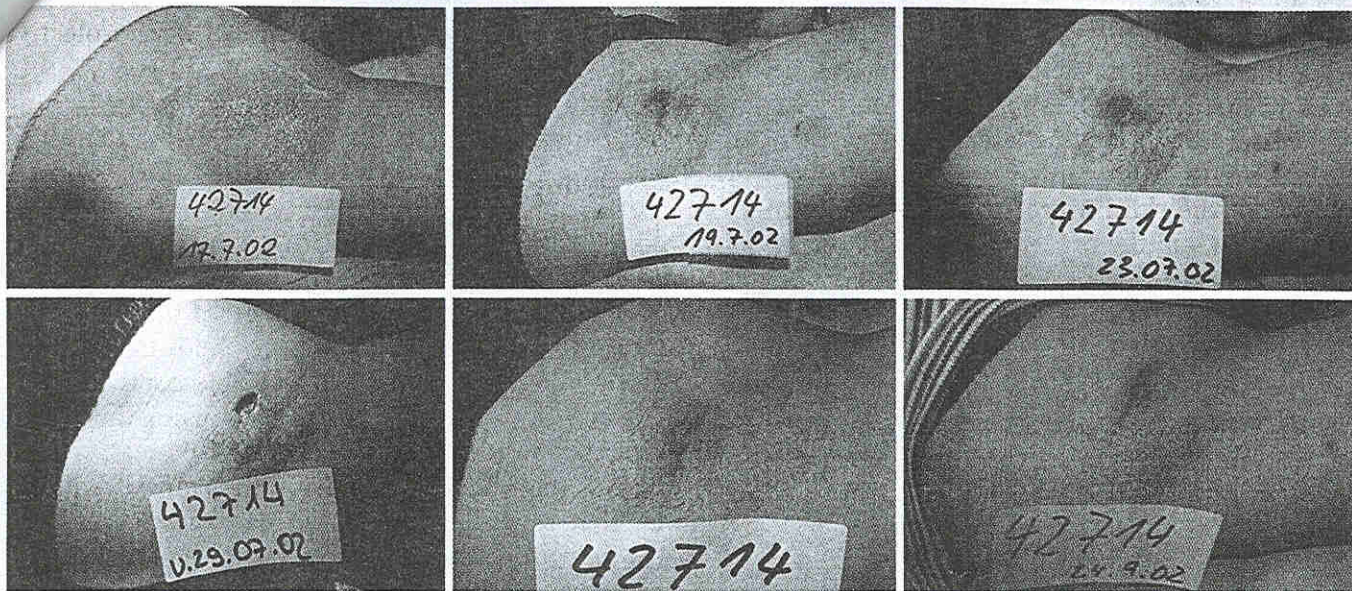
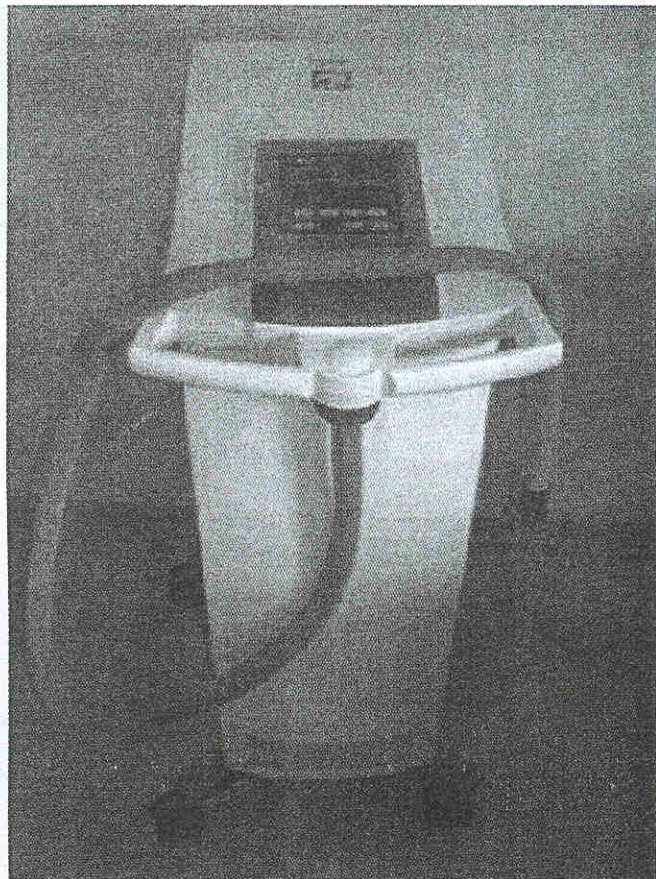


Fig. 77.10. Positioning of stab incisions. No suctioning, no laser application outside the green ellipse to avoid irregularities of the surface and skin necrosis





**Fig. 77.11.** Pitfalls: skin necrosis and healing. First surgery in March 2001, applying 15 W and 1.0 kJ/axilla with limited success for about 2 months. The left axilla is pictured after applying up to 575 J/cm<sup>2</sup>. **a** After surgery in March 2002 (2.0 kJ/axilla). **b** Two days after second surgery (4.6 kJ/axilla). **c** Emerging central necrosis. **d** Necrosis after 12 days. **e** Three weeks postoperatively. **f** After 9 weeks



**Fig. 77.12.** The tolerance of the skin to laser treatment is limited. Skin cooling helped to prevent more damage to the skin

- Another key point was the manner of administering laser energy to the skin. Stab incisions must be placed at least 4 cm away from the outlined area.

**Table 77.1.** Patient group information

Group 1: suction and laser	Group 2: laser alone
13 patients	12 patients
12 female, 1 male	8 female, 4 male
Average age 33.4 years	Average age 31.4 years
Standard deviation 9.2	Standard deviation 7.4

**Table 77.2.** Applied energy per square centimeter (Nd:YAG laser)

Group 1: suction and laser	Group 2: laser alone
98 J/cm <sup>2</sup>	142 J/cm <sup>2</sup>
Standard deviation 42	Standard deviation 30
Settings	Settings
30 W	40 W
20-ms impulse duration	20-ms impulse duration

**Table 77.3.** Months since surgery

Group 1: laser and surgery
Mean value of control period 15.5 months
Standard deviation 2.46
Group 2: laser only
Mean value of control period 13.75 months
Standard deviation 3.34

Lasering should be stopped at the rim of the target area. If you do not do this, you risk skin necrosis next to the stab incision because of cumulated laser



energy next to the incision. The remaining treatment can be administered from the opposite side.

- Laser energy has to be applied only while *retracting* the laser fiber. Applying laser energy while moving the laser fiber forwards can easily cause perforations of the skin. Moreover, as the patient often likes to watch the procedure, she or he must wear special protective glasses, as the risk of injury to

patients' eyes is high if they do not wear protective glasses as demonstrated in Fig. 77.16.

There are big differences in the size of the active sweating area that has to be treated. Thus, we measured approximately the size of the "hairy axilla" in square centimeters. Following our experience we decided how much energy per square centimeter should be applied. A simple multiplication of this dose with the number of square centimeters yields the total energy that should be applied. Reliable control of applied energy can only be obtained by using the energy "counter" in the laser control panel.

Less than half of the energy per square centimeter that caused the first skin damage was used in the following cases. Nevertheless we had one partial necrosis of the skin in a Fitzpatrick type 1 patient at  $180 \text{ W/cm}^2$ .

Safe doses of laser energy per square centimeter should be about  $100 \text{ J/cm}^2$  in Fitzpatrick type 1

Table 77.4 Side effects and complications

	Group 1	Group 2
Seroma	1	1
Hematoma more than $25 \text{ cm}^2$	1	1
Small necrosis of the skin	1	3
Restricted mobility of the shoulder for 4 weeks		1
Recurrence of sweating after 1 week		1

number  
of answers

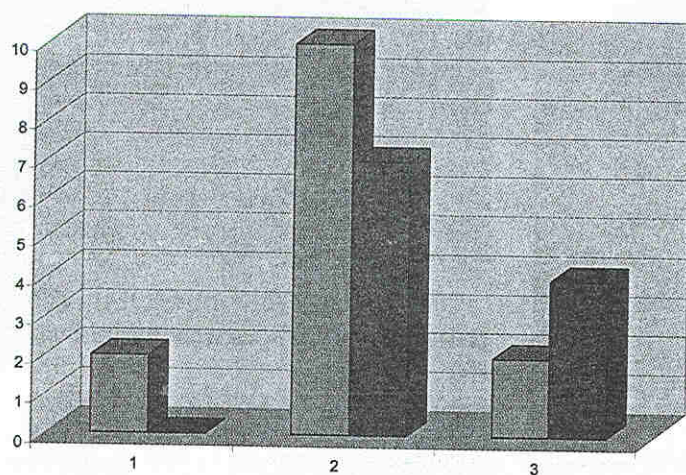


Fig. 77.13. Sweat reduction after 14 months (mean values). Laser and suction, blue bars; laser alone, purple bars

1= excellent, 2= little sweat left, 3= poor reduction of sweat

number of  
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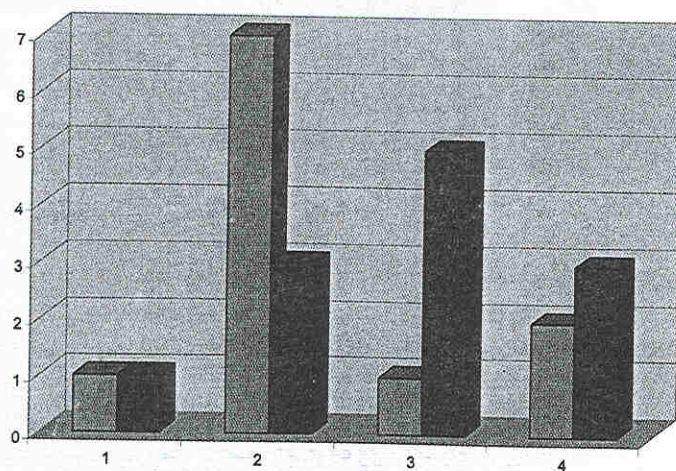
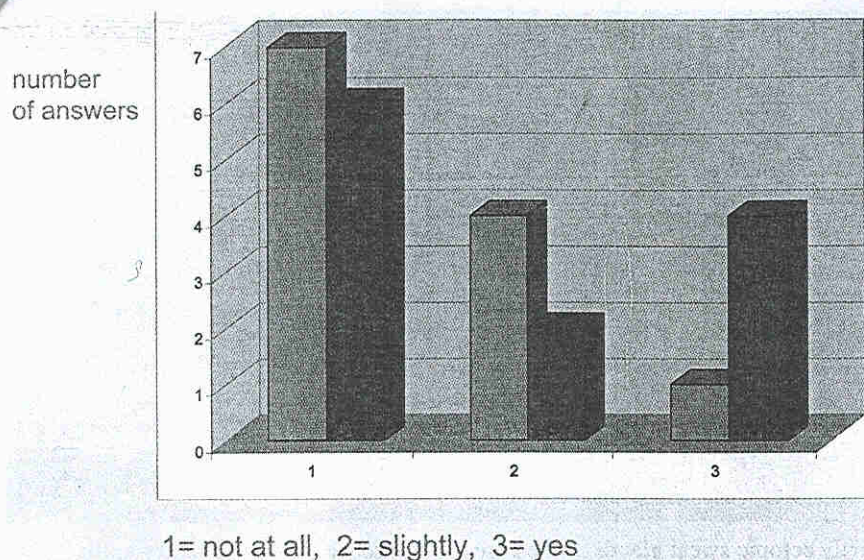


Fig. 77.14. Patient satisfaction postoperatively

1= very contented, 2=contented, 3=less contented, 4 not contented  
blue bars: laser and suction, purple bars: only laser





**Fig. 77.15.** Did surgery bother you? Laser and suction, *blue bars*; laser alone, *purple bars*



**Fig. 77.16.** Subdermal laser treatment with protected 0-6-mm bare fiber and cooling of the skin

patients and up to  $180 \text{ J/cm}^2$  in Fitzpatrick type 4 patients. While the optimal doses are not definitively established, they represent the current state of our knowledge.

## 77.7

### Ectopic Sweat Glands

A very important cause of recurrence of sweat production was revealed when we started to mark 5 cm more of the axillary skin around the "hairy" area with iodine solution. We found that significant numbers of "ectopic" sweat glands may be located outside the presumed area that were not detected in earlier cases with recurrence (Fig. 77.17).

## 77.8

### Epilation

High energy levels resulted in subtotal epilation of the central axilla. Loss of axillary hair is demonstrated and was often reported by patients (Fig. 77.18).

As mentioned before we used a Nd:YAG laser in most cases. Five months ago we started laser treatment with a diode laser with the same settings of energy application. Three patients have been treated to date, and no complaints or side effects have been reported. The results seem to resemble those obtained with the Nd:YAG laser. Further studies will be performed to compare results obtained with these different types of lasers.

## 77.9

### Histologic Observations

To date, 64 histologic specimens of axillary skin have been examined by G.F. The effect of laser energy is power-dependent. The following histologic observations in sweat glands and hair follicles were made (Figs. 77.19–77.22):

- Intracellular edema
- Intracellular vacuoles
- Desquamation
- Cell rupture
- Destruction

## 77.10

### Clinical Results

Patients treated since February 2002 have reported a decrease in sweat production of 80–90% and subtotal





Fig. 77.17. Blue line, axillary hair. Green line, partly ectopic sweat glands in the case of recurrence outside the hairy axilla

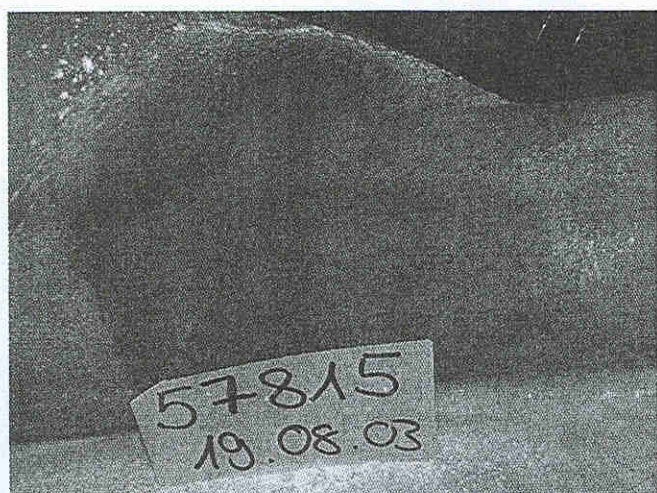


Fig. 77.18. Subtotal epilation of a left axilla 9 months postoperatively

hair removal up to 40 months. These results were verified by examination with sweat tests where possible ( $n=54$ ) or by a telephone survey ( $n=58$ ). Six patients were not satisfied with the results of their treatment, perhaps because of the learning curve we had in applying this procedure since February 2002.

## 77.11

### Observed Side Effects and Complications

- Partial skin necrosis in four cases (6%) (Fig. 77.23).
- Seroma in six cases needed puncture and evacuation (9%) (Fig. 77.24).
- Subdermal fibrosis (to be treated successfully with subdermal injections of a mixture of 5-fluorouracil and corticoids) (Fig. 77.25).
- Restricted mobility of the shoulder for 4 weeks in one case.

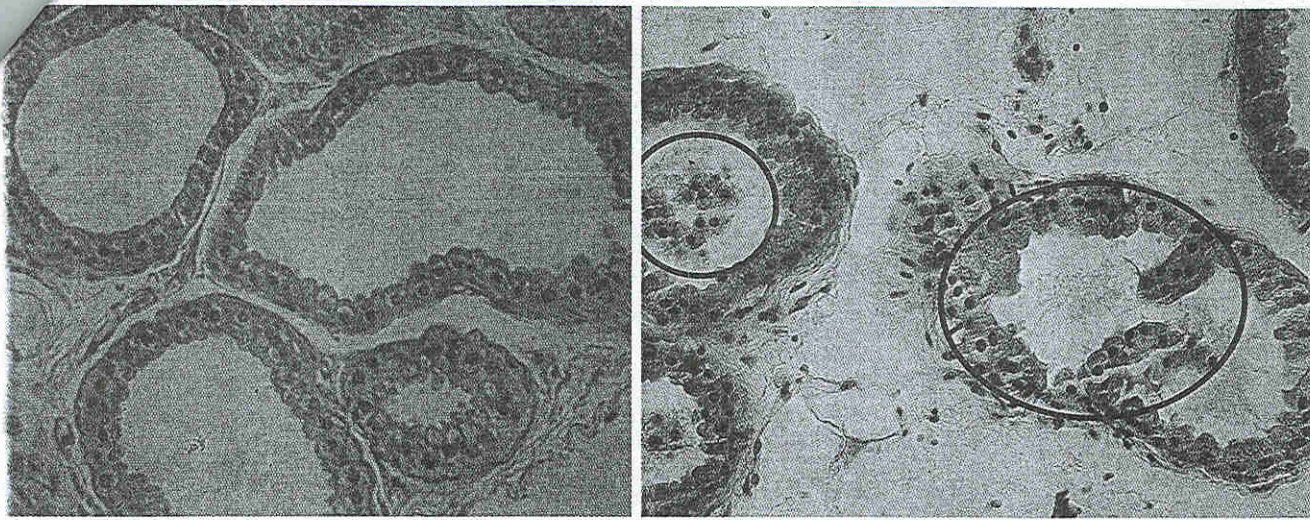
- Recurrence of sweating after 1 week without explanation.
- Lack of sensitivity of axillary skin postoperatively for 4–6 weeks is normal and cannot be considered to be a side effect.

## 77.12

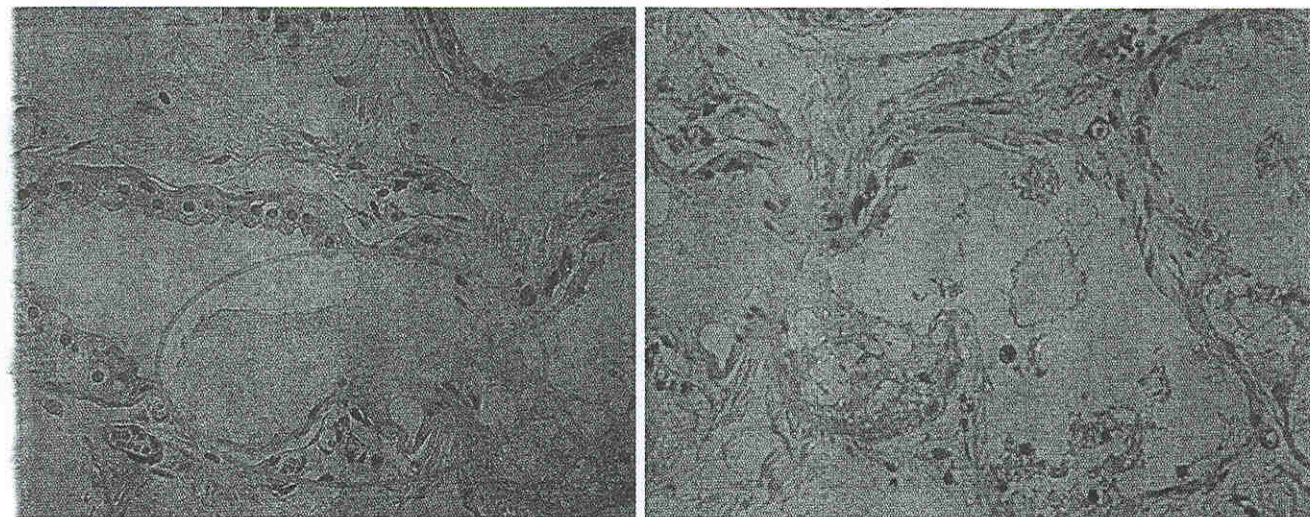
### Conclusions

- Suction alone with a blunt cannula or a Becker tip cannula is only helpful for a few weeks and can therefore not be recommended. Indeed, it has proven to be less effective than Botox injections.
- Preoperative painting of the axilla should include adjacent areas because sweat glands may be located outside the presumed treatment area.
- The laser energy that is to be applied should be adjusted according to the surface of the axilla to avoid skin necrosis.
- Cooling of the skin is recommended for treatment of the axilla with high laser energy levels.
- Underskin laser treatment with energy levels of at least  $140\text{--J}/\text{cm}^2$  or more leads to loss of axillary hair.
- The safety guidelines outlined in the next section should be strictly adhered to.
- Tissue specimens for histological evaluation should be removed no earlier than 1–2 weeks postoperatively.
- Unwanted side effects seem to be more dependent on the applied laser energy than on mechanical stress to the skin.
- Too many unwanted side effects prohibit further increase of the applied energy per square centimeter of skin.

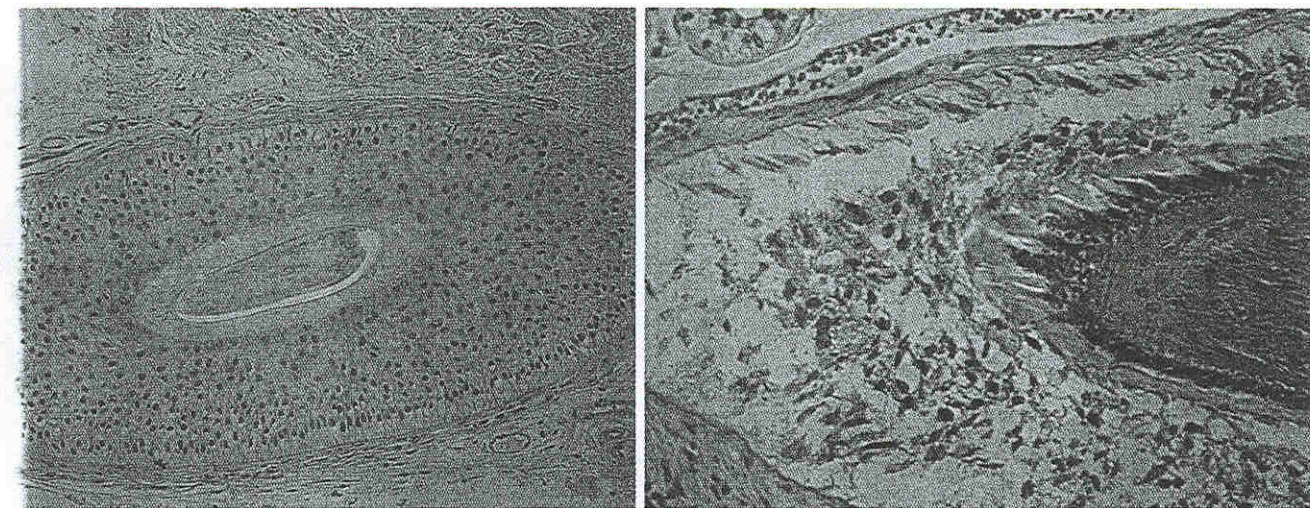




77.19. Damage after laser treatment at 15 W. Regular specimen before laser treatment (*left*). Desquamation and rupture of the glandular formation in the gland ( $100 \text{ J/cm}^2$ ) (*right*)



77.20. The lower right of the sweat gland is destroyed at 40 W (*left*). Total destruction at 40 W and  $150 \text{ J/cm}^2$  (*right*)



77.21. Regular hair follicle (*left*); totally destroyed perfollicular tissue at 40 W (*right*)



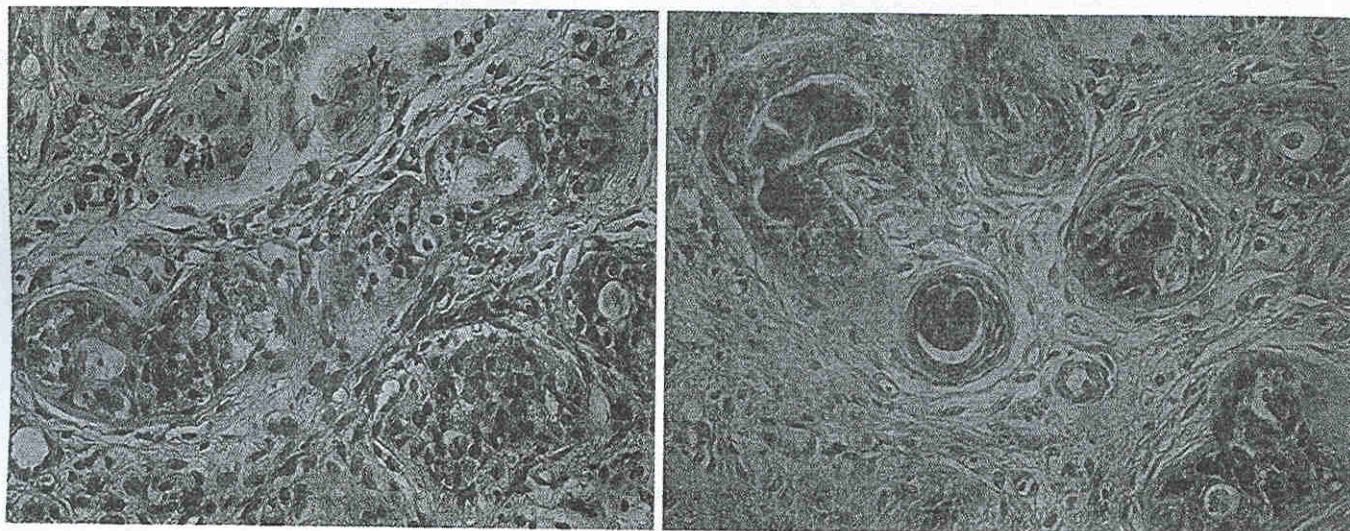


Fig. 77.22. Histological changes at 30 W and 105 J/cm<sup>2</sup> 10 days after surgery. Remainder of an acute intraoperative bleeding. Hemosiderin (left, brown); positive Berlin blue reaction (right)

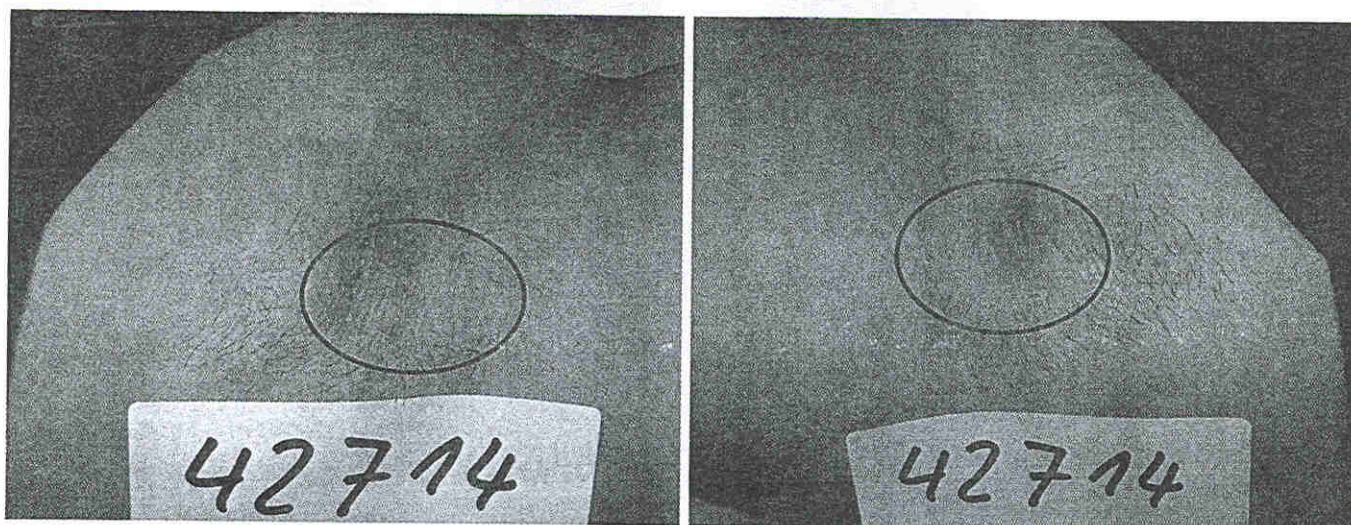


Fig. 77.23. Secondary healing after laser treatment. Note central epilation 2 weeks after surgery

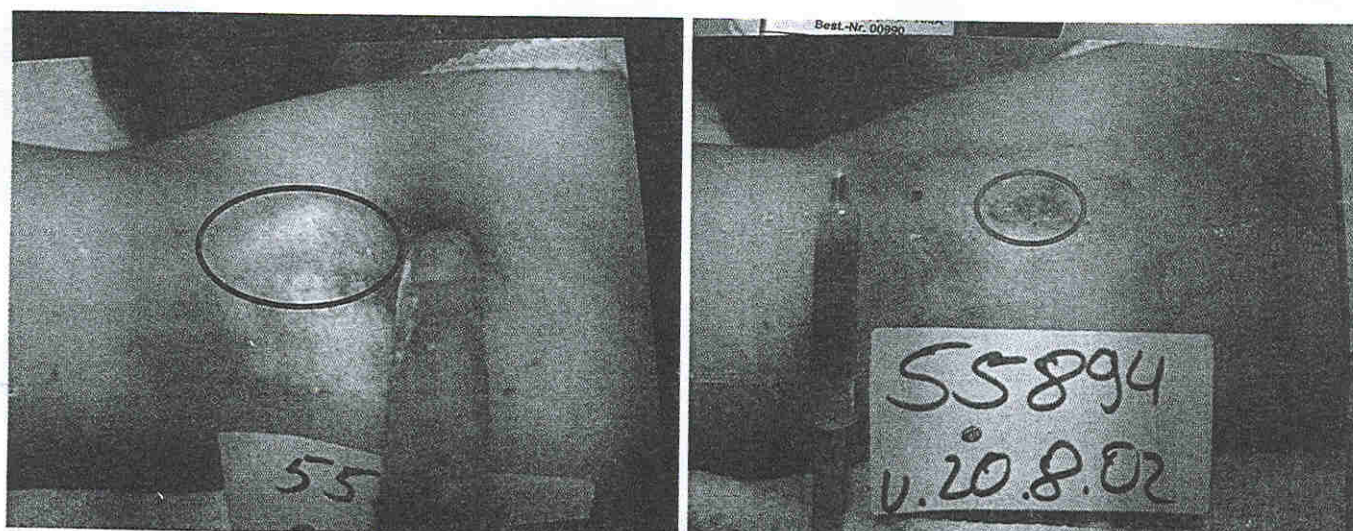
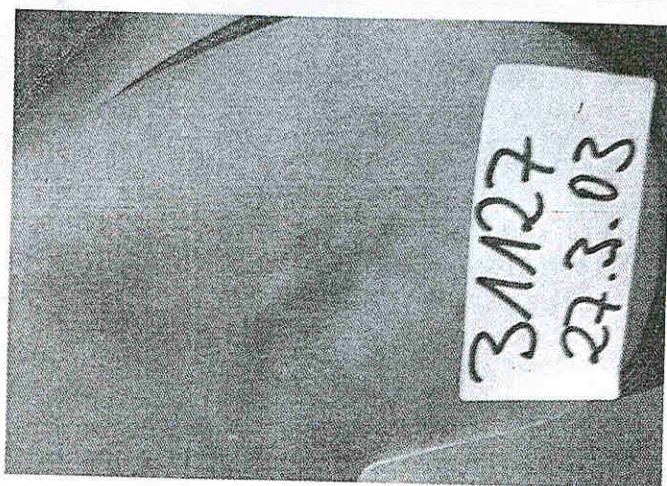


Fig. 77.24. Partial skin necrosis and seroma after laser at 180 J/cm<sup>2</sup> and suction





**Fig. 77.25.** Subdermal fibrotic "string" 3 months postoperatively

Because of the small number of cases in northern Germany a serious statistical evaluation is not yet reasonable. Our evaluation of this novel method is still in progress; however, a substantial number of successful procedures have been performed.

### 77.13

#### Safety Guidelines

- Tumescant solution should also be administered in an area extending 5 cm past the circumference of the "target zone."
- Patient and surgeon should always wear protective glasses during the laser procedure.
- Stop suctioning when you feel the rough holes of the cannula in between your fingers.
- Turn off the laser 4 cm before you reach the stab incision.
- Place the stab incision at least 4 cm outside the target area and never suction or laser outside the target area.
- Only switch on the laser when *retracting* the laser fiber, never when inserting it.
- Retract the laser fiber with a speed of about 1 cm/s.
- Cooling of the skin throughout the procedure is mandatory.