Laser Resurfacing of Silicone-Injected Skin

The “Silicone Flash” Revisited

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Objective: To determine whether prior silicone injection increases the risks associated with carbon dioxide laser resurfacing.

Design: Laboratory determination of the effect of laser energy on liquid silicone; histologic evaluation of silicone-injected skin after lasing; and histologic demonstration of silicone deposits in all layers of dermis years after injection of silicone as filler fluid.

Setting: Tertiary care medical center.

Patient-Related Data: Histologic examination of freshly excised skin injected with microdroplets of liquid silicone and subjected to application of carbon dioxide laser energy; histologic examination of skin excised years after silicone injection.

Interventions: High-speed clinical photographic imaging of the effect of laser energy on silicone fluid; histologic examination of hematoxylin-eosin–stained sections of skin injected with liquid silicone and subsequently lased.

Main Outcome Measures: Response of liquid silicone to application of laser energy; effect of this response on surrounding normal skin.

Results: Exposure of microdroplets of liquid silicone to carbon dioxide laser energy produced flaring with frank flame. Flaring of dermal silicone caused collateral skin damage.

Conclusions: Prior injection with liquid silicone is a relative contraindication to cutaneous resurfacing with the carbon dioxide laser. Surgical excision of silicone-injected skin may be preferable for many patients. A strenuous needs assessment should be done, alternatives for skin rejuvenation considered, and comprehensive informed consent obtained from the patient before embarking on laser resurfacing of silicone-injected skin.


Many thousands of patients are undergoing laser resurfacing of facial skin each year in the United States, according to the statistics currently available on the World Wide Web sites of cosmetic surgery societies. Demand is said to be growing dramatically. The expanding patient population presenting for facial skin rejuvenation must include more and more persons with historical findings of importance to the facial plastic surgeon. Although carbon dioxide (CO2) laser skin resurfacing is widely hailed as a safe and effective treatment modality,1 morbidity is widely reported as well.2 Furthermore, the patient’s medical history may affect the decision to use laser resurfacing. Weinstein3 documents currently accepted contraindications to laser resurfacing, including oral retinoid therapy, lack of skin appendages, and viral diseases, such as hepatitis B, hepatitis C, and human immunodeficiency virus infection (raising concern about the communicability of plume-borne viral particles).

A 1986 case report by Becker4 described “an incandescent flash of yellow-orange flame” on vaporizing silicone deposits that were being removed from a patient with a ruptured breast implant (Figure 1). Becker indicated his “hope that photographic documentation will stimulate others to investigate this observation further,” but no subsequent report or study has appeared to date. Treating patients with migration and other complications of prior liquid silicone injection led us to consider the use of laser resurfacing in such patients. Recall of Becker’s report suggested the following investigation.
MATERIALS AND METHODS
USE OF LIQUID SILICONE AS DERMAL AND SUBDERMAL FILLER

Liquid silicone injection for augmentation of cutaneous wrinkles and other defects was extremely popular from the 1960s to the 1980s, having been the ninth most popular cosmetic surgical procedure in the late 1980s according to the New York Times. This article further states that “59,285 injections” of liquid silicone were made in 1990, although it is impossible to determine the true origin of this number or what was meant by an injection. A casual Internet search reveals several suggestions that liquid silicone is still being used as injectable filler despite both legal disincentives and the emergence of alternatives for skin rejuvenation. A World Wide Web information site contains an inquiry dated August 17, 1999, from a patient who states that she had silicone injections around her eyes “less than six months ago.” Another website viewed on August 29, 1999, states that “[p]lastic surgery involves many aspects of body enhancement from silicone injections to breast implants.”

Plastic surgery “bulletin boards” on the Internet contain many inquiries from patients who had silicone injections in the past and are concerned about potential implications for current skin rejuvenation therapy. There are clearly thousands of patients in the community with dermal and subdermal silicone deposits. The senior author (D.R.) has surgically removed unsightly deposits of silicone from several patients over the last 20 years. It is clear that concern over silicone injections and their impact on subsequent treatment is warranted.

The literature on silicone fluid injection contains many references to the intended subcutaneous placement of the material. Authors such as Ashley et al documented their investigations into the use of silicone fluid, and clinicians such as Rees et al described using silicone fluid as a “fat substitute.” It is not clear why this was thought to be the preferred deposition depth, however, as migration seemed to occur when the material was placed in the subcutaneous fat but not when it was placed in the dermis. Figure 2 shows histologic sections from a patient whose lumpy and unsightly deposits of silicone fluid were placed between 6 and 9 years prior to excision, revealing silicone deposited throughout as deep to the dermis. Interestingly, this was reported as “fatty degeneration of the dermis” by one pathologist who was unaware of the clinical history. Furthermore, it is not logical to believe that one can repeatedly pass a needle filled with silicone fluid through the skin without depositing at least a trace in all levels through which the needle passes. As a result, we believe that most patients who underwent injection of liquid silicone have deposits at all levels within as well as beneath the dermis, as demonstrated in this and other patients of the senior author.

SELECTED FACTS ON THE PHYSICS OF LASER SKIN RESURFACING

Choi et al demonstrated that temperatures higher than 100°C were measured during CO2 laser irradiation of skin. Pulse stacking can lead to peak temperatures approaching 400°C and to tissue charring with as few as 3 stacked pulses. Thus, thermal injury in lased skin is not surprising. Multiple studies have documented the increased depth of penetration produced by overlapping laser pulses. Many others have documented scarring and hypertrophic scarring from CO2 laser irradiation of skin.

LABORATORY INVESTIGATION

Microdroplets of medical grade silicone fluid were placed on various surfaces with a 30-gauge needle on a 1-mL syringe and struck with single 5-W pulses from a CO2 laser (Sharplan Lasers Inc, Vernon Hills, Ill). High-speed digital photography was used to capture the resultant effect.

Informed consent was obtained for the use of freshly excised skin patches from amputation stump revision surgery. The skin was transported directly from the operating room to the laboratory. Microdroplets of medical grade liquid silicone were injected through the skin into the subcutaneous plane, as has been advocated in the past for facial defects. The skin samples were then lased with the CO2 laser set at 5 W, as for skin resurfacing. A single pass was made over each area.

The skin specimens were immediately placed in formalin for transfer to the pathology laboratory. Routine histologic examination was performed using light microscopy on the specimens after fixation, paraffin embedding, sectioning, and staining with hematoxylin-eosin.

Figure 2 shows a representative flame resulting from exposure of a microdroplet (0.02 mL) of silicone fluid to a single 5-W pulse of CO2 laser energy. Note the dramatic flame, which is reminiscent of Becker’s silicone flash on a smaller scale. This particular image shows lasing of a silicone droplet placed on a water-soaked tongue blade. Silicone droplets approach a spherical shape similar to their appearance in the histologic sections shown later when placed on a water-soaked surface. No damage of the underlying material was observed, and similar results were obtained on a variety of other surfaces. A tongue blade was chosen because it held the water better than ceramic and other nonporous surfaces.

Figure 3 shows a representative flame resulting from exposure of a microdroplet (0.02 mL) of silicone fluid to a single 5-W pulse of CO2 laser energy. Note the dramatic flame, which is reminiscent of Becker’s silicone flash on a smaller scale. This particular image shows lasing of a silicone droplet placed on a water-soaked tongue blade. Silicone droplets approach a spherical shape similar to their appearance in the histologic sections shown later when placed on a water-soaked surface. No damage of the underlying material was observed, and similar results were obtained on a variety of other surfaces. A tongue blade was chosen because it held the water better than ceramic and other nonporous surfaces.

A representative histologic section of silicone-injected skin that was then lased with the CO2 laser set at 5 W is shown in Figure 4. Note the thermal damage surrounding the silicone fluid droplet (Figure 4B, arrowheads).

Becker observed and described flaming of liquid silicone when it was contacted by the energy beam from a CO2 laser. We confirmed that this also happens when silicone microdroplets in the dermis are lased. We have demonstrated histologically that silicone fluid contaminates the full thickness of soft tissue through which the needle passes, despite an intent not to inject until the tip reaches the subdermal fat. We have demonstrated thermal in-
jury in the skin around intradermal silicone deposits. As a result, we are convinced that the potential for scarring is real when lasing skin previously injected with liquid silicone, despite the intended injection deeper than the laser penetrates. Temperatures in skin exposed to a single pass of a CO₂ laser reach 100°C, and can reach in excess of 400°C after 3 passes. These temperatures are sufficient to cause full-thickness burns and resultant scarring. The addition of an open flame from lased silicone deposits is highly likely to cause scarring.

On the basis of our observations, we believe that prior injection with liquid silicone is a relative contraindication to CO₂ laser resurfacing. From Becker, we
know that larger deposits of liquid silicone produce a dramatic flame. Therefore, visibly lumpy silicone deposits should be treated by direct excision of the skin island containing them. Whenever possible, direct excision of silicone-containing skin is preferred over any attempt to resurface the area, in our opinion.

CONCLUSIONS

Prior injection with liquid silicone is a relative contraindication to skin resurfacing with a CO₂ laser. Unsightly deposits of liquid silicone should be treated by direct excision of the skin island harboring them. Punch excision and grafting would be appropriate to manage isolated deposits before lasing. Alternatives to laser resurfacing should be considered strongly. Should both the facial plastic surgeon and the patient choose CO₂ laser resurfacing for treatment, comprehensive informed consent must be obtained. The laser should be used in single-pass mode, with great care taken to avoid overlapping pulses. Multiple treatment sessions with minimal penetration are preferable to deeper lasing in a single treatment episode. The use of lasers with less depth of penetration than first-generation CO₂ units should be considered. Further work needs to be done to determine if a particular type or class of laser minimizes the risk of thermal injury and scarring when used on silicone-injected skin.

REFERENCES