Three Hundred Patients Treated with Ultrapulsed 980 nm Diode Laser for Skin Disorders

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Abstract
The use of lasers in skin diseases is quite common. In contrast to other laser types, medical literature about 980 nm ultrapulsed diode laser is sparse in dermatology. Herein, we report the use of ultrapulsed diode 980 nm laser in 300 patients with vascular lesions, cysts and pseudocysts, infectious disease, and malignant tumors. This laser is a versatile tool with excellent safety and efficacy in the hands of the experienced user.

Key Words: 980 nm diode laser, benign tumors, cutaneous metastases, plantar warts, ultrapulsed laser, vascular lesions

Introduction
Diode lasers are among the most efficient converters of electrical energy into laser light. Various tissue reactions can be induced this was such as coagulation, vaporization, or welding.[1]

The 980 nm diode laser is widely used in dentistry, urology, gynecology, and vascular medicine.[2-5] Surprisingly, the literature about 980 nm diode laser use in dermatology is very sparse. Ultrapulsed 980 nm diode laser offers some advantages. Choosing very short exposure times, heat that is generated into the tissue cannot diffuse in the adjacent parts and local overheating occurs. This will result in vaporization at temperatures >300°C. The pulse duration of microseconds will ablate tissue into fragments.[6]

Here, we wish to report on experience with an ultrapulsed 980 nm diode laser in 300 patients with various dermatologic complaints.

Patients and Methods
The ultrapulsed 980 nm diode laser Ceralas HPD (Biolitec, Jena, Germany) with focus diameter between 0.6 and 1.6 mm has been used. The maximum power of this laser is 120 W. Laser treatment was individually tailored by power, pulse duration, and pulse pause. Pretreatment by either topical or local anesthesia was used ad libitum.

We prefer a eutectic mixture of local anesthetic cream (AstraZeneca, Wedel, Germany) that is a topical anesthetic cream base containing lidocaine (2.5%) and prilocaine (2.5%). Local anesthesia was done by injection of 1.0% prilocaine (Xylonest; AstraZeneca, Wedel, Germany). In other cases, no anesthesia was used. During the procedure, patients and medical staff yielded protective goggles.

We report on the first 300 patients treated by ultrapulsed 980 nm diode laser, comprising 206 females and 84 males. The age range was 6–84 years, with mean 53 ± 22 years. In the following section, we will report on treatment of various skin diseases. Since some patients were treated for more than one indication, the number of dermatoses exceeds the number of patients.

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**Vascular lesions**

For vascular lesions, pulse duration was $\leq 0.01$ s and pulse pause was 0.3–0.5 s. The power varied between 25 and 40 W. Cherry angioma ($n = 42$), venous lake of the lip (18), angiokeratoma (5), spider nevus (48), and granuloma telangiectaticum (18) responded very well to a single laser treatment. Healing was without scars [Figure 1].

One penile hemangioma in a child was treated in one session under general anesthesia with complete remission and without scar formation [Figure 2].

For cavernous lip angiomas (5), forced dehydration technique with short pulse pauses was employed successfully. In all patients, $\leq 2$ laser sessions were sufficient for complete remission. There was no scar development and no texture or color change [Figure 3].

Capillary malformations (port wine stains; $n = 9$) needed a series of treatments. It was taken care not to overlap laser shots to avoid pigmentary changes and ulcerations. The time interval between laser sessions was $\geq 2$ weeks. The aim was a significant bleaching effect [Figure 4]. However, a complete disappearance of these lesions is impossible. Again, no scars were observed. Extrafacial lesions in adults did not need anesthesia in most cases.

Facial telangiectasias (63) and couperose (31) can also be treated with the 980 nm diode laser. Nasal telangiectasias are particularly painful. The pulse duration should be at least three times shorter than pulse pause to avoid ulcerations. Couperose needs a series of treatments to obtain good results. This should be accompanied by sun protection and rosacea treatment with topical metronidazole [Figure 5].

Spider leg veins not responding to sclerosing therapy may be treated by diode laser (54). The red spiders are responding better than the blue ones. Spider leg veins may develop again after a certain period of time.

**Cysts and pseudocysts**

Scrotal cysts (4) and mucoid pseudocysts of fingers and toes (11) can be treated in a single session. The same is true for hidrocystoma (3), syringoma (4), and mucocele (3). Pulse duration is up to 0.1 s for larger cysts [Figure 6].

**Keloids**

Keloids can be treated by laser during the phase of redness (7). Here, the target of laser therapy would be sprouting vessels. Diode laser can reduce the redness. There is no effect on width and height of keloids. For this purpose, the treatment has to be combined with ablative lasers and/or intraliesional corticosteroids. No induction of further growth of keloids has been observed after exposure to diode laser [Figure 7].

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**Figure 1:** Ultrapulsed 980 nm diode laser for multiple Fordyce angiokeatromas of the scrotum

**Figure 2:** Angiomas of the penis. (a) Before treatment. (b) Immediately after ultrapulsed 980 nm diode laser with eschar formation

**Figure 3:** (a) Lip hemangioma. (b) Immediately after ultrapulsed 980 nm diode laser application the lesion was shrunked and blanched

**Figure 4:** Port wine stain on the back. (a) The scars resulted from a neodymium-yttrium aluminum garnet laser treatment several years ago. (b) During the first session with ultrapulsed 980 nm diode laser with blanching effect

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**Figure 5:** Spider leg veins after ultrapulsed 980 nm diode laser treatment

**Figure 6:** Port wine stain before and after treatment with ultrapulsed 980 nm diode laser

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**Figure 7:** Keloids before and after treatment with ultrapulsed 980 nm diode laser
Plantar warts
Plantar warts are particular treatment resistant ($n = 95$). Here, pulse duration of 0.1–0.2 s was used with an equally long pulse pause. Power was between 40 and 100 W. This leads to thermal coagulation without plum formation in contrast to erbium-yttrium aluminum garnet (YAG) or CO$_2$ laser. Laser treatment for larger plantar warts needs general anesthesia. The relapse rate of 7.4% is less than that for erbium-YAG laser, but reinfection cannot be prevented.

Cutaneous satellite melanoma metastases
Melanomas tend to develop sometimes multiple small-sized satellite metastases. We have treated six patients with numerous lesions on the scalp or the extremities. Pulse pause was reduced to 0.1–0.2 s with pulse duration of 0.1 s. The power was adjusted to the individual needs (30–90 W). Healing was fast and scarless.

Adverse effects
Diode laser treatment is painful. Pain depends on laser parameters, body region, and individual factors. Therefore, topical or local anesthesia may be used. Minor bleeding was noted for cavernous hemangioma and granuloma telangiectaticum.

Care has to be taken to avoid scars and hypopigmentation by adaption of power, pulse duration, and pulse pause. Protective goggles are indispensable to avoid accidental injury to the eyes.

Discussion
The 980 nm diode laser is a versatile tool in dermatology. In this paper, we reported on transcutaneous laser application only, but it has also been applied subcutaneously or intravascular to induce laser lipolysis to assist liposuction or to coagulate varicose leg veins.

Diode lasers offer a rather deep tissue penetration. By changing laser parameters, different tissue effects can be generated. This opens a broad range of possible indications. Surprisingly, the literature on transcutaneous use of ultrapulsed 980 nm diode laser in skin disease is sparse.

Here, we report on 300 patients treated by this technique. The first important indication is vascular lesions. Benign capillary or venous lesions such as cherry angioma, venous lake of the lip, angiokeratoma, spider nevus, and granuloma telangiectaticum, and penile hemangioma respond in 100% with a complete remission after a single treatment. For superficial cavernous hemangiomas, a forced dehydration technique was used successfully. Capillary malformations, facial telangiectasias, and couperose warrant several sessions to obtain satisfying results. Capillary malformations (port wine stains) are genetically heterogeneous. Nonsyndromic variants are due to mutations in GNAQ gene. Capillary malformations of the face respond better than those of the trunk; smaller lesions gain a better outcome than larger ones. Since capillary malformations are composed of vessels of various calibers and depth, their treatment remains a challenge and complete response is rare. Spider leg veins are a common esthetic problem. Treatment of choice is sclerotherapy. Those veins not responding can be treated by various lasers. Pulsed diode lasers obtain good clinical results, but scarring is a possible adverse effect. With ultrapulsed 980 nm diode laser, no scarring was observed. Red spider leg veins responded better than blue ones.

Mucocutaneous cysts and pseudocysts such as benign adnexal tumors, mucocele, and mucoid pseudocyst can easily be treated by 980 nm diode laser. For larger lesions, we prefer the forced dehydration technique with longer pulse duration but shorter pulse pauses. In contrast to erbium-YAG laser, the relapse rate is lower.
Keloids are benign connective tissue tumors with increased blood perfusion in the early stage. This is the target for vascular lasers in keloid treatment.\[24\] Good clinical results have been obtained in earlobe keloids.\[27\] We obtained blanching effect. For optimal outcome, treatment must combine anti-inflammatory and ablative approaches.

Plantar warts are common lesions induced by infection with human papillomavirus types. Plantar warts tend to be treatment-resistant. That may lead to large and deep penetrating plantar lesions. Ablative CO\(_2\) lasers are effective but produce plume that is potentially infectious. The erbium-YAG laser offers the advantage of noninfectious plume, but penetration is limited.\[18\] In an open trial, 13.5% of plantar warts did not respond in contrast to 5.9% of periungual warts.\[20\] The combination of erbium-YAG laser with podophyllotoxin achieved a response rate of 88.6% versus 72.5% with laser alone.\[29,30\] Ultrapulsed 980 nm diode laser treatment obtained a relapse rate of 7.4% within 3 months after clearance compared to 24.0% with the erbium-YAG laser.\[29\]

In a palliative setting, malignant tumors and metastases may be treated with laser. In dermatology, cutaneous satellite metastases of melanoma are of particular importance. Bulky metastases should be treated surgically. If patients develop multiple minute metastases, laser therapy is an option. Surprisingly, there is an absence of recurrences at treated sites which cannot completely be explained. Probably, changes in tumor microenvironment by laser therapy are responsible.\[31,32\] Ultrapulsed 980 nm diode laser is as effective as CO\(_2\) laser in this indication. It is patient friendly, of low-cost and simple.

**Conclusion**

Transcutaneous laser therapy with ultrapulsed 980 nm diode laser is a versatile tool for a large variety of skin diseases. Due to deep penetration and very short pulses, texture and color of skin are protected and nonscarring healing is possible.

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**Conflicts of interest**
There are no conflicts of interest.

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