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ORIGINAL ARTICLE

Efficacy of Nd-YAG laser for treatment of pyogenic granuloma on the fingers and toes

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Abstract

Pyogenic granuloma (PG) is a common benign vascular proliferation which often occurs on the head, neck, hands, and feet. Among the various treatment options for PG, surgical excision is the most effective treatment which offers the lowest overall recurrence rates and also provides the exact diagnosis. However, it could have difficulties to do the surgery when lesions are located on the fingers and toes, especially very near to the nails, so laser may be a very good alternative choice. In this article, we evaluated the clinical efficacy and safety of neodymium-yttrium aluminum garnet (Nd:YAG) laser for treatment of PG located on the fingers and toes. Twenty-one patients with 21 PGs located on the fingers and toes were treated by multispot Nd-YAG laser. We chose monopulse (pulse width 10.5–13.5 ms; energy 100–125 J/cm^2); treatment interval was 3–4 weeks. All lesions disappeared after one or two treatments. There was no apparent scar formation, no impact on the function of the fingers and toes, no damage to nail growth, and no recurrence in more than 12-month follow-up. Nd-YAG is an effective and safety treatment option for treatment of PG located on the fingers and toes.

Keywords Pyogenic granuloma · Nd-YAG laser · Fingers · Toes

Introduction

PG, also known as lobular capillary hemangioma, is a benign vascular proliferation that occurs chiefly in children, adults, and pregnant women [1]. Although it can occur at any sites of the body, clinically, we find it most often on an exposed surface, such as the head, neck, trunk, hands, and feet; some lesions can even involve the mucosa, especially on the gingiva [1–3]. Typically, PG is presented as a red or dark red papule or nodule, usually slow growing, but at times showing rapid growth, and can bleed easily with minor trauma. Although some PGs may resolve spontaneously, most will require treatment [4].

There are various treatment options for PG, such as surgical excision, cryotherapy with liquid nitrogen, carbon dioxide laser ablation, pulsed dye laser (PDL), Nd-YAG laser, erbium-YAG laser, diode laser, electrocoagulation, sclerotherapy with monoethanolamine oleate or with sodium tetradecyl sulfate, topical 5% imiquimod cream, topical timolol 0.5% ophthalmic gel, 1% propranolol cream, systemic steroids, intralesional bleomycin injection, radiation treatment, and photodynamic therapy (PDT) with 5-aminolevulinic acid [5–12]. Some of them are not used frequently because of the high recurrence rates or the side effects (usually scarring). According to some study, surgical excision is the most effective treatment which offers the lowest overall recurrence rates and also provides the exact diagnosis [5]. However, some have difficulties to do the surgery on large lesions or lesions, located on some sensitive areas such as the face, and periungual. Here, we report successfully treating with Nd-YAG laser 21 patients with 21 PGs located on the fingers and toes, most of them were difficult surgeries either because of the large size or nearness to the nails.

Materials and methods

Twenty-one patients (12 females, 9 males, from March 2013 to March 2016) with 21 PGs located on the fingers and toes were treated with Nd-YAG (multispot Nd-YAG laser, 1064 nm, Lumenis, USA). Treatments were conducted every

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3–4 weeks: laser wavelength 1064 nm, spot size 6 mm, single-pulse mode (pulse width 10.5–13.5 ms; energy 100–125 J/cm^2). Local anesthesia was either with compound lidocaine cream (qinghua ziguang) for 1 h or lidocaine hydrochloride injection without adrenaline; some patients did not accept any anesthesia. Most of the PGs needed more than one laser shot, and we used overlap-pulse mode, both vertically and from the laterals when the PGs were protruding; treatment endpoint was obvious coagulation with dark purple or gray white color. Cooling with cold water bag was used immediately after the treatment to relieve any uncomfortable feelings. Usually, there is no need to dress the lesions after treatment except for not contacting water frequently; only lesions with obvious inflammation before treatment need mupirocin for topical use. Crusts were seen after 2–3 days and would last for 2–4 weeks.

All the patients were diagnosed with PGs by two experienced dermatologists. To exclude malignancies or other vascular tumors (such as Kaposi sarcoma, amelanotic melanoma, basal cell carcinoma, squamous cell carcinoma, hemangioma, etc.), only cases that had obvious clinical features were included in our study. In addition to clinical diagnosis based on natural history and physical examination, dermoscopic examination was also applied to improve diagnostic accuracy according to the recommended criteria [13–15]. For some uncertain cases, especially when the lesions were large and were difficult to cut off, histologic confirmation was made before laser treatment. Any lesion that had not ruled out malignancy was excluded. All patients were treated by the same doctor. Before treatment, all patients would be thoroughly informed about the possible side effects, such as pain, swelling, bleeding, scar, and recurrence. Written informed consent was obtained. Digital photographs were taken before treatment and at each subsequent follow-up visit.

Results

All the 21 patients finished the laser treatment and all of them got perfect clinical results. Patients' age ranged 9–71 years (mean 40 ± 1.75 years) and disease duration from 2 weeks to 30 years (mean 12 weeks). Eighteen lesions (85.71%) were located on the fingers; three lesions (14.29%), on the toes. The PG diameters were 3 to 18 mm (mean 7.29 ± 3.98 mm). Before treatments, 15 patients (71.43%) received local anesthesia, 9 patients (42.86%) received local lidocaine hydrochloride injection without adrenaline, 6 patients (28.57%) received local compound lidocaine cream (prilocainum 25 mg and lidocaine 25 mg per g), and 6 patients (28.57%) were without any anesthesia.

All the PGs were cleared after one or two laser treatments. Eleven lesions (52.38%) needed just one laser treatment and 10 lesions (47.62%) needed two laser treatment sessions. The

Table 1 Patient characteristics

Sex	Age	Site	Diameters (mm)	Treatments (*n*)	Parameters: pulse width (ms) and energy (J/cm^2)	
F	41	Finger	10	1	11.5	125
F	31	Finger	10	2	12/11.5	120/100
F	55	Finger	4	2	11.5/11.5	115/115
F	64	Finger	3	1	11.5	110
F	26	Finger	6	2	11.5/11.5	100/105
F	28	Finger	7	1	11.5	105
F	26	Finger	4	1	11.5	101
F	30	Toe	4	1	11.5	110
F	9	Finger	4	1	11.5	115
F	70	Finger	8	2	11.5/11.5	110/105
F	21	Finger	9	1	11.5	115
F	41	Finger	5	1	11.5	105
M	31	Finger	4	1	11.5	100
M	33	Finger	12	2	11.5/11.5	60–110/90–101
M	56	Toe	18	2	11.5/10.5	105/103
M	59	Finger	4	2	11.5/11.5	105/110
M	34	Finger	5	2	11.5/11.5	108/105
M	34	Finger	8	1	11.5	101
M	71	Finger	5	2	11.5/11.5	120/110
M	57	Toe	15	2	13.5/11.5	125/120
M	23	Finger	8	1	11.5	120

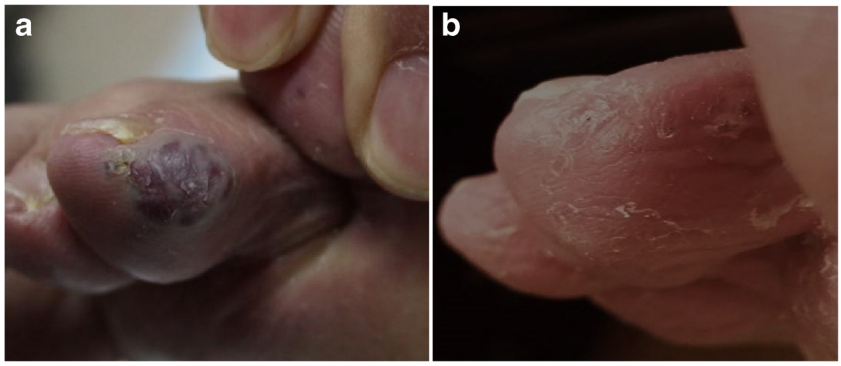

Fig. 1 PG on the right second toe of a 56-year-old patient. **a** Before treatment and **b** 3 months after two treatment sessions with Nd-YAG laser (first treatment session: pulse width 11.5 ms, energy 105 J/cm^2; second treatment session: pulse width 10.5 ms, energy 103 J/cm^2). There was slight scar formation

average pulse width was 11.55 ± 0.42 ms; treatment session was 1.48 ± 0.52; the average energy was 109.65 ± 7.57 J/cm^2 (Table 1). At the end of the study, no patients had recurrence for at least 12 months (either by clinic visit or phone call).

As for the side effects, all patients (100%) felt a certain degree of pain during and few hours after the treatment, the skin around the lesions became swollen in all the patients(100%), which got much better after cooling with a cold water bag; during the laser treatments, 4 patients (19.05%) bled which stopped after immediate compression; 5 patients (23.81%) developed a slight scar, which all of them accepted very well because the scars were very slight and neither affected aesthetics nor function. The nails were not affected at all.

Discussion

Professor Godfraind C and colleagues [16] found that PG being a reactive lesion resulting from tissue injury was followed by an impaired wound healing process associated with vascular growth driven by FLT4 and the nitric oxide pathway. So, they thought PG to be a reactive lesion and not a tumor.

However, other studies have shown that most lesions develop without any preceding trauma or predisposing dermatologic condition [2, 17]. Recent evidence has been provided that activating RAS mutations is causally involved in a small subgroup of sporadic PG [18] and Groesser L et al. [19] identified the BRAF c.1799T>A mutation as a major driver mutation in the pathogenesis of sporadic and particularly secondary PGs. The natural course of this lesion can be categorized into three distinct phases: the cellular phase, capillary phase/vascular phase, and involutionary phase. Histopathologically, PG in general is composed of numerous capillaries and edematous fibroblastic proliferation in the stroma that surround the vascular lesion. Some PGs even show deep extension into subcutaneous fat [20]. Lasers with selective photothermolysis characteristics and tissue penetration are used very frequently in various skin disease treatments. PDL of 585 or 595 nm is maximally absorbed by oxyhemoglobin, leading to photocoagulation. PDL was considered as the gold standard for the treatment of vascular diseases. Several doctors, such as Goldberg DJ et al. [21], Glass AT et al. [22], González S et al. [23], and Miller PK et al. [24], had all successfully treated PG by either 585 or 595 nm PDL and got excellent clinic and cosmetic results. Treatment sessions were from one to four; recurrence rates were very low. However, PDL has a limited

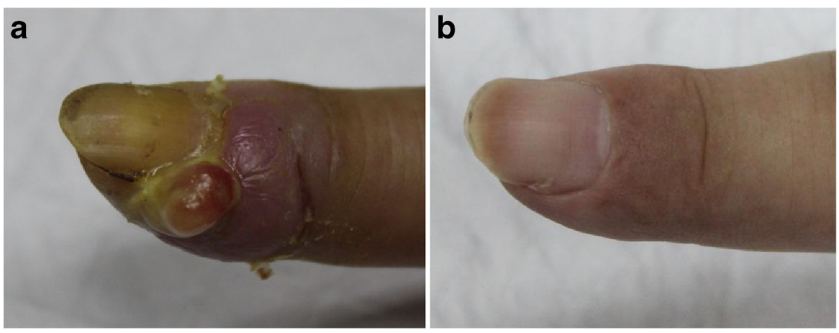

Fig. 2 PG on the right index finger of a 33-year-old patient: **a** before treatment; **b** 3 months after two treatment sessions with Nd-YAG laser. There were obvious swelling and some purulent exudates around the PG. The patient had dressing-change treatment with rivanol for three times in our clinic before laser treatment. However, there was no improvement. We treated both the PG (first treatment session: pulse width 11.5 ms, energy 110 J/cm^2; and second treatment session: pulse width 11.5 ms, energy 101 J/cm^2) and the swelling around (first treatment session: pulse width 11.5 ms, energy 60 J/cm^2; second treatment session: pulse width 11.5 ms, energy 90 J/cm^2) by Nd-YAG laser. The PG disappeared completely, so did the swelling around. There was no scar formation

penetration in the skin, and thus it is insufficient to penetrate deeply in the majority of PG, so the deeper vessels are not irradiated, leading to some recurrence. Sud AR et al. [25] treated PG by shave-excision and/or PDL. Their experience was treating smaller PG (< 5 mm) with PDL alone and larger lesions (5 mm or larger) with shave-excision immediately followed by PDL to the base. They showed an average of 1.8 PDL treatments for lesions < 5 mm and larger lesions required an average of 2.7 treatment sessions for eradication. All the patients got satisfactory cosmetic outcomes. However, bleeding after the shave-excision sometimes is hard to control. The Nd-YAG laser is known for its high tissue penetration up to 1 cm and with a blood vessel coagulation effect, it is now considered to be an appropriate option for treating voluminous hemangiomas. In 2006, Bourguignon R and colleagues [26] treated 3 patients with PG on the finger, on the thumb in the nail matrix zone, and on the gum. They got good results without any long-term recurrence. In 2009, Bédard MS and colleagues [27] treated 25 patients with PG. The total number of treatments varied from 1 to 6; 44% percent of patients cleared with only one treatment. No recurrence was noted at the 2-month follow-up visit. Ninety-six percent of the patients were very satisfied or satisfied with the treatment and its results. In 2012, Hammes S and colleagues [28] also treated 20 patients with PG by Nd-YAG laser. They showed recurrence-free healing in 19 of 20 patients (follow-up ≥ 6 months); 1 patient changed to carbon dioxide laser because of heavy bleeding. The cosmetic results were good; textural changes of the skin were slight.

We also used multispot Nd-YAG laser for treatment of PG and got favorable clinical and cosmetic results. We specially evaluated the clinical efficacy and safety of Nd-YAG laser for treatment of PG on the fingers and toes, where there are usually difficulties to do the surgery. We treated 21 patients with 21 PGs, 18 on the fingers, and 3 on the toes (diameter varies from 3 to 18 mm). All the lesions were cleared after one or two treatments. No recurrence was noted at the more than 12-month follow-up visit. Five patients developed slight scar and none affected the function of the fingers and toes (see Fig. 1). Compared with other studies, our treatment sessions were relatively fewer. We thought it was because we applied wide pulse width with higher energy and overlapped pulses. So, our treatment intervals were 3–4 weeks, some even longer. All the patients were very satisfied with the clinical results. In one patient (see Fig. 2a), the lesion was near the site of the nails and there was obvious inflammation (erythematous, swelling, and oozing lesion) around the PG; before treatment, we had given him rivanol solution, wet packing, and mupirocin cream for topical use for a few days, and there was no improvement. When we treated the PG, we also treated the inflammated areas with lower energy (first treatment 60 J/cm^2; second treatment 90 J/cm^2). With the PG getting better, the erythema and swelling got better too; after two sessions of treatment, the PG disappeared, so did the erythema and swelling lesion (see Fig. 2b); so, we thought that the low-energy laser might have some anti-inflammatory function and could promote the healing process. However, a large sample and further investigation are needed to verify the anti-inflammation function of the laser.

Conclusion

Treating PG using multispot Nd-YAG laser yields favorable clinical results, with good cosmetic as well as almost recurrence-free outcomes. With the exception of malignant diseases, Nd-YAG laser is a very good alternative option for treating PG, especially large lesions on the finger and toe or lesions very near the site of the nails which are difficult sites for the surgery.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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