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Pyogenic granuloma – Nd:YAG laser treatment in 450 patients

Granuloma pyogenicum – Nd:YAG-Laser-Behandlung von 450 Patienten

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Abstract

Background and objective: Pyogenic granuloma (PG) also known as "eruptive hemangioma", "granulation tissue-type hemangioma", "*granuloma gravidarum*", or "lobular capillary hemangioma", are well-demarcated, rapidly exophytic growing benign, usually pedunculated red (vascular) tumors on skin or mucosa. They belong to the group of capillary angiomas, but differ from infantile hemangioma. Occurrence is mostly posttraumatic, but also spontaneously, especially in children and pregnant women. A high risk of complication as bleeding or infection results from the vulnerable surface. Conventional surgical excision, cautery or cryotherapy may lead to relapse in addition to visible scar formation. Thus we remove PGs using laser, in most of cases with a continuous wave Nd:YAG laser.

Methods: Before therapy, PGs of skin were initially rated in size and vascularization using color-coded duplex sonography. Usually the Nd:YAG laser (1064 nm) was employed. Laser settings and techniques were adjusted appropriately; i.e. pulsed, chopped or continuous wave for *in-situ* coagulation, in impression technique or by direct coagulation. Bigger and more pedunculated tumors have been coagulated at the base in a perpendicular fashion with bare fiber. The present paper is a retrospective cohort study of PGs which have been treated since the year 2000 in our clinic at the Ev. Elisabeth Klinik Berlin, Germany. In order to review our learning curve, the patients were divided into two groups according to the period of treatment: 1) patient group between the years 2000–2004; 2) patient group between the years 2005–2013.

Results: In total, 450 patients with 454 PGs were treated between the years 2000–2013. The size of PGs at time of treatment was 2–15 mm. Forty percent of PGs showed former bleeding. Seventy-six percent (n=344) of PGs occurred during the first two decades of life; 60% of cases in this group (n=205) occurred during the first 5 years of age. Taken as a whole, no gender predominance (♂: 52%; ♀: 48%) was found. Interestingly in the first year of age there was a male predominance (♂: 61%); in contrary a female predominance (♀: 63%) in middle age was seen. Eighty percent of angiomas were located in the head-neck region, particularly on eyelids. In the years 2000–2004, 70% of cases were treated with the Nd:YAG laser; a single session was sufficient in 93% of this cases, and the recurrence rate was 7%. In contrast, in the years 2005–2013, Nd:YAG laser treatment was performed in 94% of cases with a recurrence rate of less than 4%. The most effective application mode was the use of the Nd:YAG bare fiber technique, for both coagulation *in situ* and radical removal with <1% recurrences. No complications such as postoperative bleeding or infection appeared. Clinical outcome was scored by two independent evaluators blinded to type and number of treatments by rating the postoperative control images and could be completed for 199 out of 450 patients. The cosmetic results, especially in the facial area (containing lips and eyelids), were good or excellent in 60% of the cases (n=120).

Conclusions: Laser treatment proved to be a successful method with no relevant side effects or complications. Scarring was observed in 40% of the cases (n=79) and thus less compared with shave excision and cautery. Hence, it can be suggested to include the Nd:YAG laser into the options of first-line therapy for PGs.

Keywords: hemangioma; vascular lesion; bare fiber; laser therapy.

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Zusammenfassung

Hintergrund und Zielsetzung: *Granuloma pyogenicum* (PGs), auch bekannt als „eruptive Hämangiome", „granulationsgewebeartige Hämangiome", „Granuloma gravidarum", oder „lobular kapilläre Hämangiome", sind gut abgrenzbare, schnell exophytisch wachsende und in der Regel gutartige, gestielte, rote (vaskuläre) Tumoren der Haut oder der Schleimhaut. Sie gehören zu der Gruppe der kapillären Angiome, unterscheiden sich aber von den infantilen Hämangiomen. Sie treten hauptsächlich posttraumatisch auf, aber auch spontan, besonders bei kleinen Kindern und schwangeren Frauen. Aufgrund der empfindlichen Oberfläche besteht ein großes Risiko für Komplikationen wie Blutungen oder Infektionen. Konventionelle chirurgische Exzision, Kauterisation oder Kryotherapie können zu Rückfällen und Narbenbildung führen. Deshalb entfernen wir PGs mittels Laser, in den meisten Fällen mit einem cw Nd:YAG-Laser.

Methodik: Vor der Therapie wurden zunächst die Größe und die Ausdehnung der kutanen PGs mittels Farbdopplersonographie bestimmt. Für die meisten Behandlungen wurde der Nd:YAG-Laser (1064 nm) eingesetzt. Lasereinstellungen und Techniken wurden entsprechend angepasst; z. B. gepulst, getaktet oder cw bei lokaler Koagulation mit Impressionstechnik oder mit direkter Koagulation im Non-Contact-Modus. Größere und gestielte Tumoren wurden an der Basis zuerst mit der "bare fiber" koaguliert, dann abgesetzt. Die vorliegende retrospektive Kohortenstudie analysiert die Behandlungsergebnisse an unserer Klinik über einen Zeitraum von 2000–2013. Zur überprüfung unserer Lernkurve erfolgte die Auswertung in zwei Gruppen in Abhängigkeit vom Behandlungszeitraum: 1.) Patienten, die im Zeitraum 2000–2004 behandelt wurden; 2.) Patienten, die im Zeitraum 2005–2013 behandelt wurden.

Ergebnisse: Insgesamt wurden 450 Patienten mit 454 PGs in der Zeit von 2000–2013 behandelt. Die Größe der PGs lag zwischen 2 und 15 mm. 40% der PGs zeigten vorhergehende Blutungen. 76% (n=344) der PGs traten während der ersten beiden Lebensjahrzehnte auf; 60% der Fälle in dieser Gruppe (n=205) traten während der ersten 5 Lebensjahre auf. Im Ganzen fanden wir eine gleichmäßige Verteilung auf beide Geschlechter (♂: 52%; ♀: 48%). Interessanterweise gibt es jedoch im ersten Lebensjahr eine männliche Dominanz (♂: 61%), im Gegensatz dazu eine weibliche Dominanz in der mittleren Altersgruppe (♀: 63%). 80% der Angiome befanden sich im Kopf-Nacken-Bereich. Zwischen 2000–2004 wurden 70% der Fälle mit dem Nd:YAG-Laser behandelt; in 93% dieser Fälle reichte eine Sitzung aus. Die Rückfallrate betrug 7%. Zwischen 2005–2013 wurden 94% der Fälle mit dem Nd:YAG-Laser behandelt bei einer Rückfallrate von 4%. Am effektivsten war die Anwendung des Nd:YAG-Lasers mit der "bare fiber", sowohl bei lokaler Koagulation als auch radikaler Entfernung mit einer Rückfallrate von <1%. Es kam zu keinen Komplikationen, wie postoperativen Blutungen oder Infektionen. Die Beurteilung des klinischen Ergebnisses erfolgte durch zwei unabhängige, hinsichtlich Art und Anzahl der Behandlungen verblindete, Gutachter anhand der postoperativen Kontrollbilder und konnte für 199 der 450 Patienten abgeschlossen werden. Die kosmetischen Ergebnisse, besonders im Gesicht (mit Lippen und Augenlidern) waren in 60% (n=120) der Fälle gut oder exzellent.

Fazit: Die Nd:YAG-Laserbehandlung hat sich als erfolgreiche Methode mit geringen Nebenwirkungen oder Komplikationen erwiesen. Die Sicherheit der Behandlung ist wie bei der tangentialen Exzision mit Elektrokoagulation hoch. Narben sind bei der Lasertherapie seltener, deshalb sollte der Nd:YAG-Laser in die erste Reihe der Therapieoptionen der PGs eingeordnet werden.

Schlüsselwörter: Hämangiome; vaskuläre Läsion; bare fiber; Lasertherapie.

1 Introduction

Pyogenic granuloma (PG) also known as "eruptive hemangioma", "granulation tissue-type hemangioma", "*granuloma gravidarum*" or "lobular capillary hemangioma", are well-defined, rapidly exophytic growing benign, often pedunculated, red (vascular) tumors on skin or mucosa. They belong to the group of capillary angiomas, but differ from infantile hemangioma. They may regress within 6–18 months [1], often causing local complications during this period.

Usually, growth is rapid within a few weeks [2] – ranges are variable from millimeters to centimeters; a larger number of the tumors are pedunculated. Early lesions appear as bright red, sessile or pedunculated well-defined spherical tumor with intact surface. Older lesions often show vulnerable surface, crusts, infections or bleeding.

Occurrence is seen posttraumatic [3], but also spontaneously. Children and pregnant women are mainly affected although they can develop in people of all ages [4]. A high risk of complications as bleeding or infection results from the vulnerable surface.

The pathogenesis is unknown; a correlation with minor trauma and pregnancy is repeatedly reported [4]. We observed a number of PGs within capillary malformations in patients with Sturge-Weber syndrome.

PGs may be clinically confused with spider naevus, small infantile hemangiomas (IHs) and tuberous transformations in port-wine stains. Usually, history, clinical appearance and typical findings in color-coded duplex sonography (CCDS) are efficient to settle the clinical diagnosis.

In histopathology, typical features are found: lobular proliferation of small blood vessels of the dermis which erupt in the epidermis, and a single layer of endothelial cells lining the vessels surrounded by a mixed cell population (Figure 1). Older lesions may present fibrosis.

Shave excision combined with cautery is used as first-line treatment [1]. This conventional surgical excision often causes visible scars. Cautery alone or cryotherapy may lead to relapse in addition to some visible scar formation. Pulsed Nd:YAG (1064 nm), flashlamp-pumped pulsed dye (FPDL) (585–595 nm) or frequency-doubled Nd:YAG (KTP) (532 nm) lasers have been used to effectively treat small lesions with minor risk of scarring but failed in larger lesions as with regard to our data of the first 4 years.

This retrospective cohort study reports on the treatment of 450 patients with 454 PGs treated with pulsed and continuous wave (cw) Nd:YAG lasers as well as argon ion laser (514 nm), KTP laser and FPDL in smaller portions of the cohort.

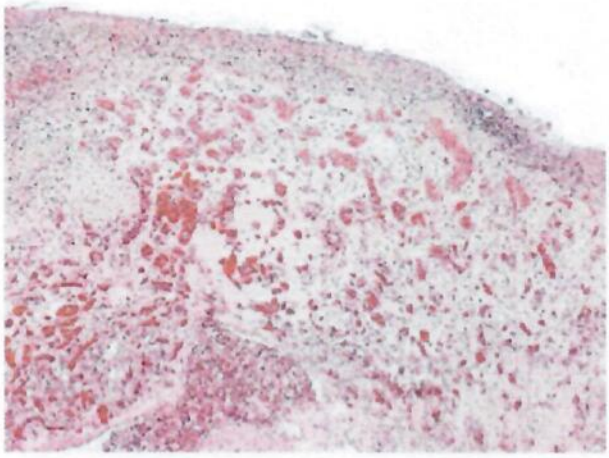

Figure 1: Histology of PG with typical features to be found: lobular proliferation of small blood vessels of the dermis which erupt in the epidermis, and a single layer of endothelial cells lining the vessels, surrounded by a mixed cell population. Older lesions may present fibrosis.

2 Subjects and methods

2.1 Study design

In this retrospective cohort study 450 patients with 454 PG lesions, who were treated in our clinic at the Ev. Elisabeth Klinik Berlin, Germany, where included. All patients were referred from practicing physicians or other clinics. Treatments dated between the years 2000 and 2013. Medical records and photographs before and after treatment, and during a follow-up appointment (usually after 6 weeks) were analyzed.

In order to review our learning curve, the patients were divided into two groups according to the period of treatment: 1) patient group between the years 2000 and 2004, and 2) patient group between the years 2005 and 2013.

Clinical outcome was scored by two independent evaluators blinded to type and number of treatments by rating the postoperative control images and could be completed for 199 out of 450 patients. Ratings where as follows:

- Excellent=no signs of lesion, no signs of treatment, no scarring;
- Good=no signs of lesion, minor color or texture changes, no scarring;
- Less favorable=no signs of lesion, dimples, pigment changes, scarring.

2.2 Laser therapy

2.2.1 Selection of laser type

Before therapy, all PGs were initially rated in size and vascularization using CCDS. The size of the lesions ranged from 2 to 15 mm in diameter. Usually, the Nd:YAG laser was employed. Laser settings and techniques were adjusted appropriately; i.e. pulsed, chopped or cw, and in impression technique or by direct coagulation to achieve *in-situ* coagulation. Larger and more pedunculated tumors were coagulated at the base in a perpendicular fashion with bare fiber first and then cut-off with the fiber for radical removal. Pulsed Nd:YAG laser was used in smaller findings. Alternatively, visible lasers such as argon ion laser, KTP laser or FPDL were used during the considered time period (2000–2004 and 2005–2013), but predominantly in the first 4 years. All of those utilized the "coagulation *in situ*" approach.

2.2.2 Used laser techniques

2.2.2.1 Coagulation *in situ*

Small lesions were exposed with a pulsed Nd:YAG laser (focus, 2.5 mm; exposure time, 3–4 ms; fluence, 110–135 J/cm²) with repeated exposures until significant shrinking occurred (Figure 2A–C). Alternatively, chopped direct exposure was used with 20 W, 0.2 s exposure time and 0.2 s interval; again until visible shrinking was noted.

Medium-sized lesions with a wide base were treated with a cw Nd:YAG laser (focus, 1 mm; laser power, 25 W) through clear ice cubes which were held in contact with skin and PG until shrinking occurred (Figure 3A–C). Direct exposure or exposure through ice cubes were realized by using a focusing handpiece.

In medium and larger-sized PGs with a wide base a freshly cleaved bare fiber (core diameter, 550 µm) was used in contact mode (impression technique) with 5 W cw until blanching and shrinking occurred. This method was particularly suitable if larger feeding vessels were present in order to occlude it by pressing the fiber perpendicularly into the feeder artery. Surrounding skin in the direction of the beam was cooled by ice cubes held in contact with skin (Figure 4A and B).

2.2.2.2 Radical removal

In larger and pedunculated PGs with a small base a freshly cleaved bare fiber (core diameter, 550 µm) was used. The base was coagulated in non-contact or impression technique with a freshly cleaved bare fiber followed by contact vaporization of the base and resection of the PG (fiber with pre-carbonized end and in contact with tissue). The usually present feeder artery was occluded by pressing the fiber perpendicularly into the feeder artery and firing the laser (5 W, cw). As usual in our clinic, ice-cube cooling was used to protect the surrounding tissue in most cases (Figure 5A–F).

After laser treatment, the wound was cared by polyvidon (PVP)-iodine ointment which was secured with a wound dressing for 24 h. Either petrolatum or protective wound cover alone was used thereafter.

Figure 2: Coagulation *in situ* approach. (A) Color-coded duplex sonography image of small PG, (B) pulsed Nd:YAG exposure (focus, 2.5 mm; exposure time, 3 ms; fluence, 110 J/cm²), and (C) directly after exposure.

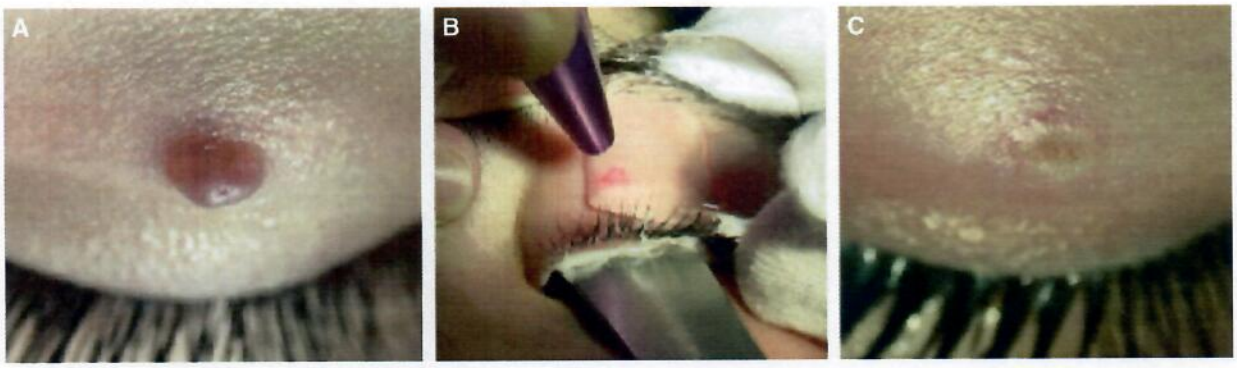

Figure 3: Trans-ice exposure using a handpiece. (A) PG of the eyelid before treatment, (B) during cw Nd:YAG-laser exposure (25 W) trans ice with eye-shielding by metal spatula, and (C) immediate result.

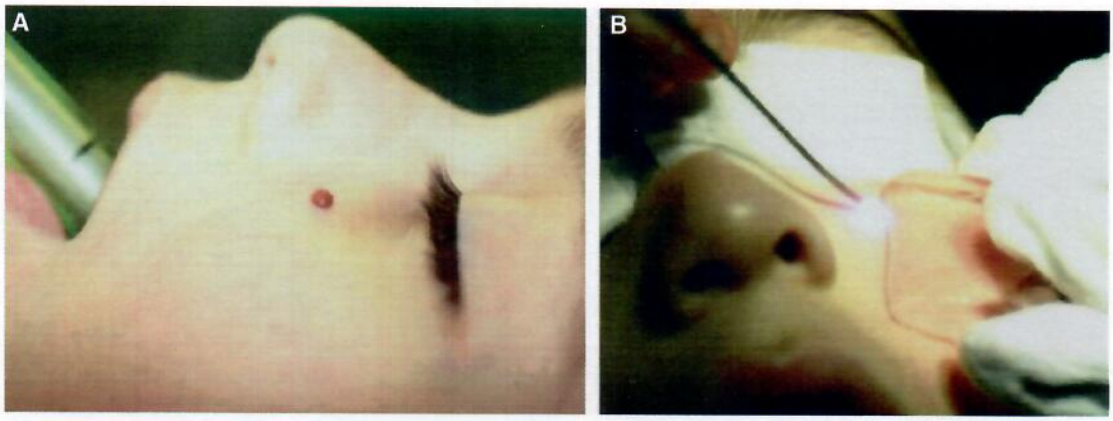

Figure 4: Impression technique using a bare fiber (core diameter, 550 µm) at 5 W, cw. (A) PG of the cheek before treatment. (B) Ice-cube cooling for protection of surrounding tissues.

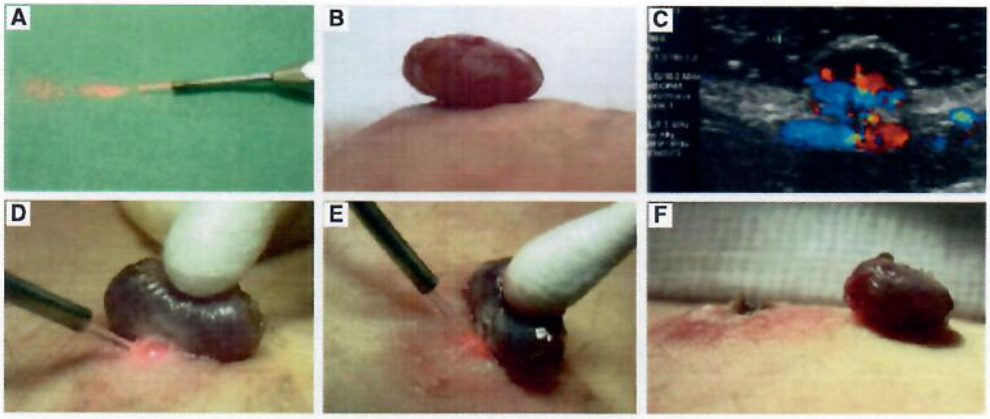

Figure 5: Radical removal approach. (A) Emission profile of the bare fiber within a handpiece. (B) Clinical image and (C) color-coded duplex sonograpy image of lager pedunculated PG with feeder vessels. (D) Coagulation of the base with a cw Nd:YAG laser (5 W) and freshly cleaved fiber, (E) cutting off the base with cw Nd:YAG laser (5 W) and carbonized fiber tip, and (F) resected PG with remaining feeder vessels coagulated by *in-situ* impression technique.

3 Results

3.1 Patients

In total, 454 PG lesions in 450 patients were treated between the years 2000 and 2013. The size of the lesions varied between 2 and 15 mm at the base. In about 40% of the patients bleeding prior to therapy was reported.

3.1.1 Age distribution

Age distribution showed a dominance of younger ages. In total, 344 patients (76%) were younger than 20 years with 205 patients being between 0 and 5 years, and 139 patients being between 6 and 20 years old. Seventy-seven patients up to 5 years were younger than 1 year, 128 between 1 and 5 years old. A total of 60 patients (13%) were between 21 and 40 years of age, 26 (6%) between 41–60 and 24 (5%) older than 60 years of age (Figure 6).

3.1.2 Gender distribution

Gender distribution was equal between the two sexes (52% male vs. 48% female). But by looking at age-related distribution, dominance in males below 20 years was found, while females were more affected after the age of 20 years (Figure 7).

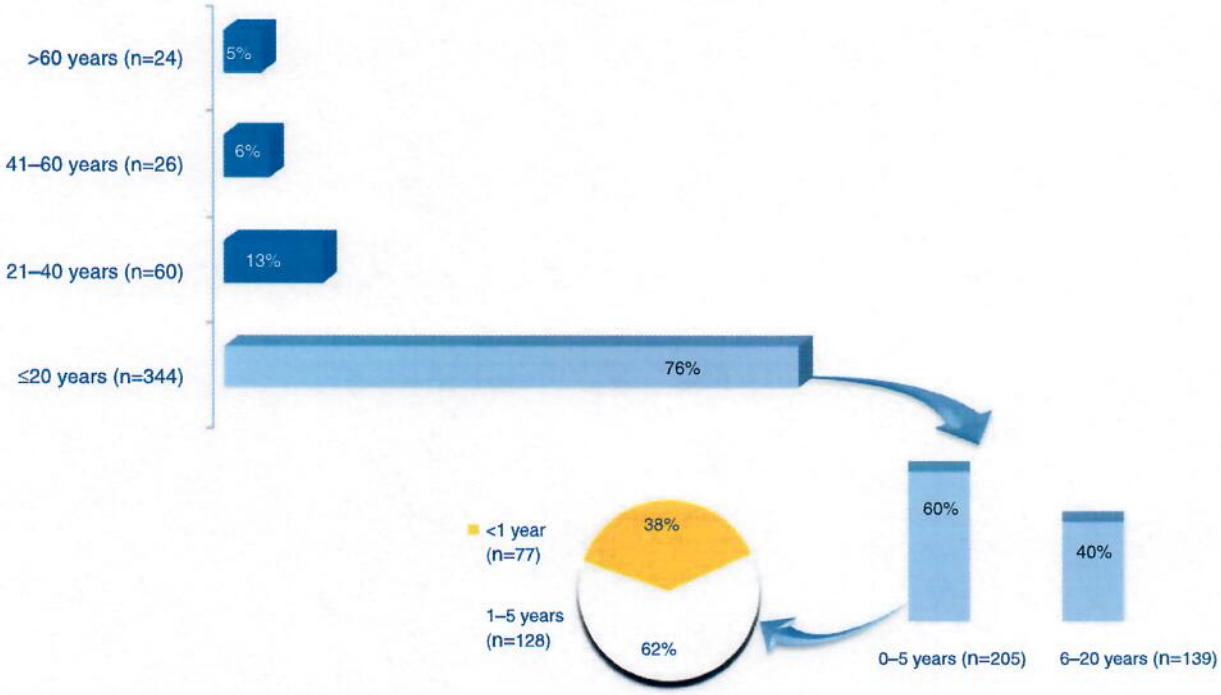

Figure 6: Age distribution in 450 patients with PG.

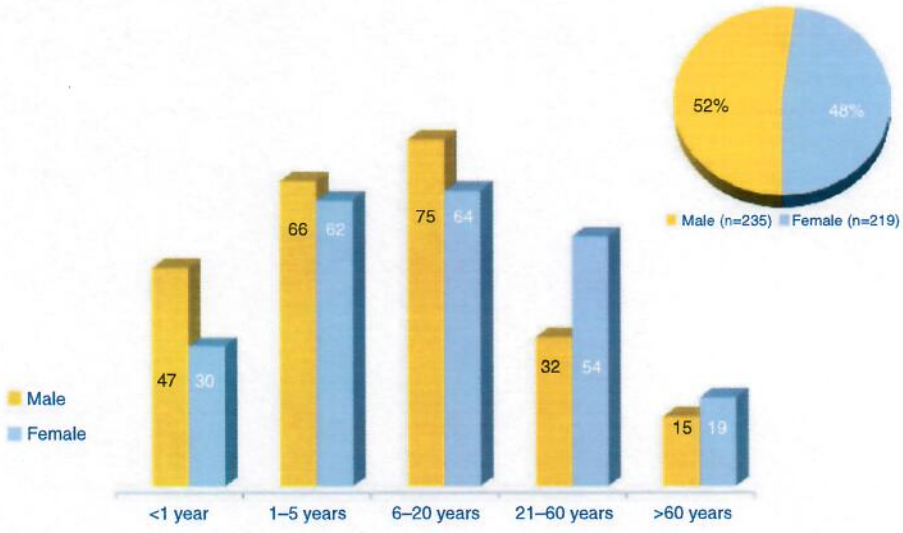

Figure 7: Gender vs. age distribution in 450 patients with PG.

3.1.3 Clinical localization

Far the most lesions (80%, n=363) where located in the head and neck region. Looking exclusively at patients younger than 6 years this number rises to 95% (n=194) whereas patients older than 6 years presented only 68% in the head and neck region and 16% on the trunk and extremities each (Table 1).

Table 1: Localization vs. age distribution in 454 PG lesions.

Clinical localization	Age group		Total (number;%)
	<6 years (number;%)	>6 years (number;%)	
Head-neck	194 (95)	169 (68)	363 (80)
Trunk	6 (3)	40 (16)	45 (10)
Extremities	5 (2)	40 (16)	46 (10)
Total	205 (100)	249 (100)	454 (100)

At head and neck region the eyelid was the predominant single location (25%, n=91), lips and nose were affected in 11% each (n=38 and n=39 respectively), the other 51% (n=188) were distributed through all other regions as neck, cheeks and even the hairy head (Figure 8).

3.1.4 Clinical outcome

Clinical evaluation by two blinded investigators could be completed in 199 patients as the remaining 251 patients did not show up for control and consequently no completed photodocumentation exists. Some of those "no shows" called in and mentioned they would see no reason for control as everything had healed. In the evaluated 199 patients, scarring was noted in 40% of the cases (n=79). Only atrophic scarring appeared in those patients and no hypertrophic scars have been documented. No signs of scarring were noted in 60% (n=120) of the controls, with 32% showing excellent results (excellent=complete, *ad integrum*) and 28% with good results (good=no signs of lesion, minor color or texture changes, no scarring).

Table 2: Results of PG treatment in 199 patients.

	Clinical outcome (number;%)
Excellent[a]	63 (32)
Good[b]	57 (28)
Less favorable (with scarring)[c]	79 (40)
Total	199 (100)

[a]Excellent=no signs of lesion, no signs of treatment, no scarring.
[b]Good=no signs of lesion, minor color or texture changes, no scarring.
[c]Less favorable=no signs of lesion, dimples, pigment changes, scarring.

In 40% of lesions with a larger base scarring were seen more frequently (Table 2). Some images of individual PGs may illustrate the categories of ratings (Figures 9–14). No complications such as postoperative bleeding or infection were noted.

3.2 Learning curve

The evaluation was separated in two groups with regard to our learning curve and used laser techniques. From 2000 to 2004, 142 PGs were treated and from 2005 to 2013, 312 PG lesions were treated.

3.2.1 Period 2000–2004

Between 2000 and 2004 a total of 142 PG lesions were treated. In this time period, the Nd:YAG laser was used in

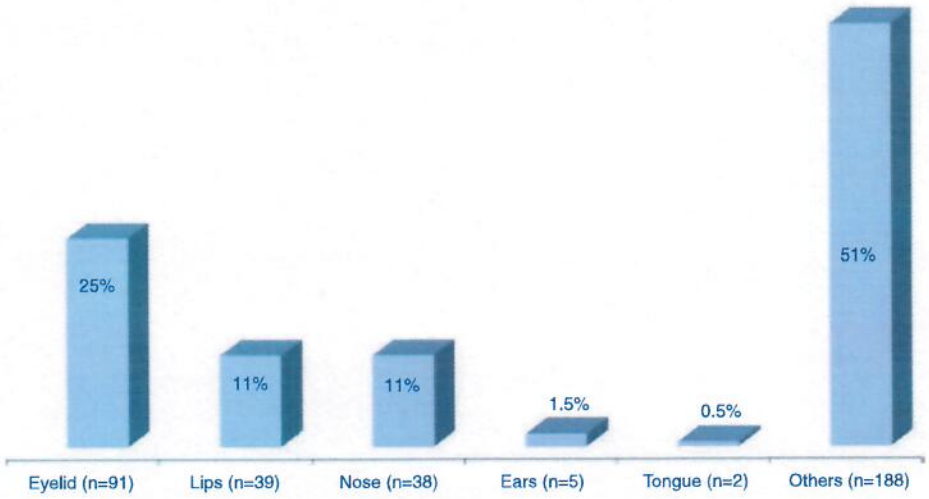

Figure 8: Distribution of PGs in the head & neck region.

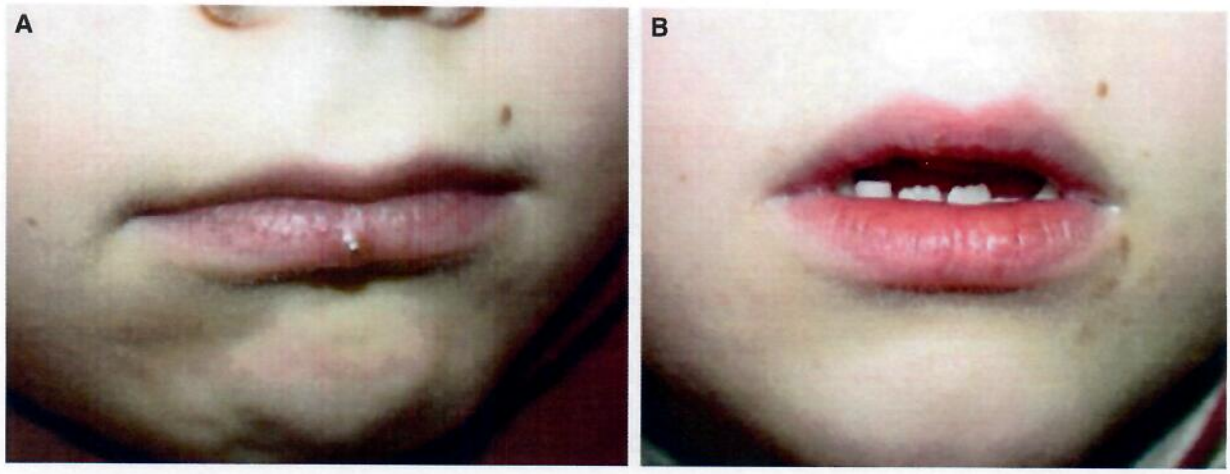

Figure 9: PG at the lower lip (A) before and (B) after laser treatment with excellent cosmetic result.

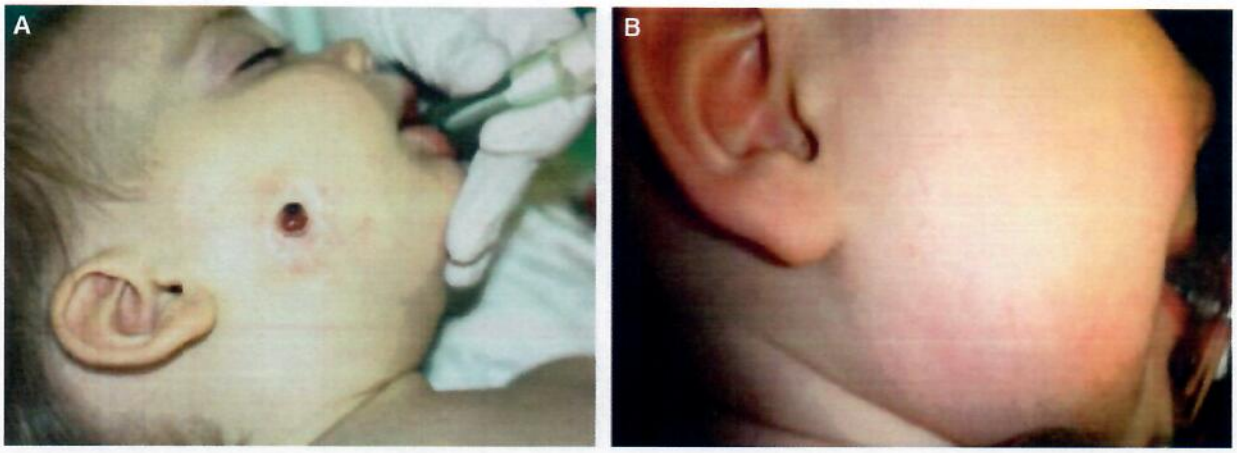

Figure 10: PG at the right cheek (A) before and (B) after laser treatment with excellent cosmetic result.

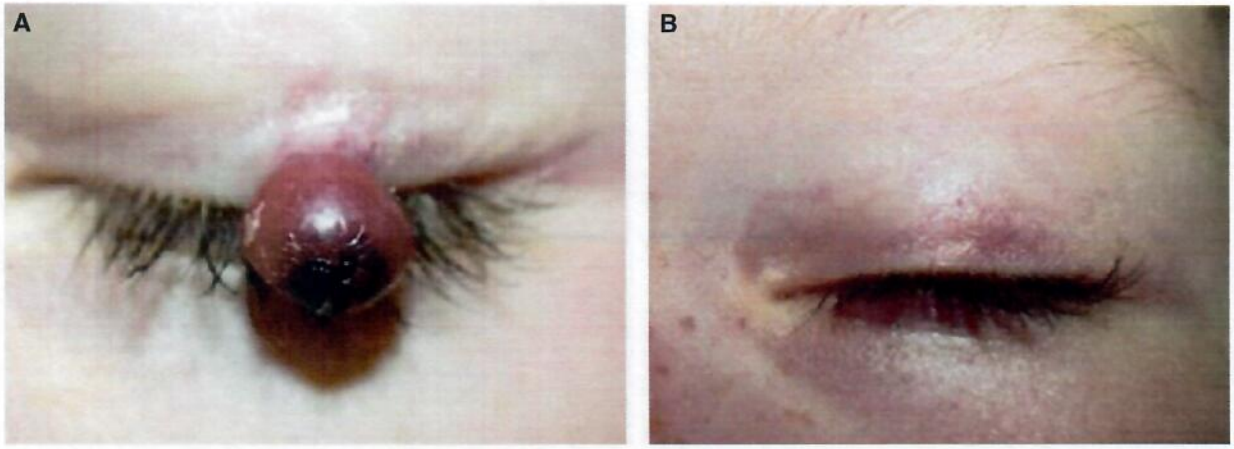

Figure 11: PG at the left eyelid (A) before and (B) after laser treatment with good esthetic result.

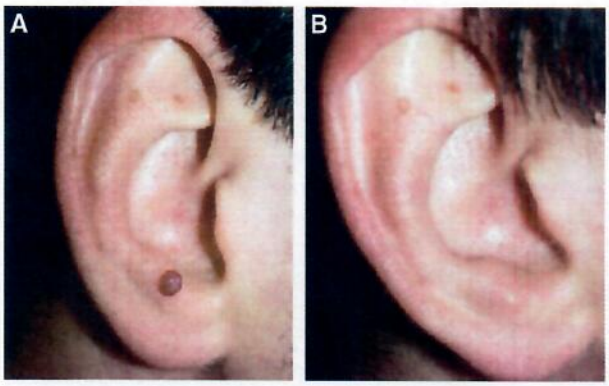

Figure 12: PG at the right earlobe (A) before and (B) after laser treatment with good cosmetic result.

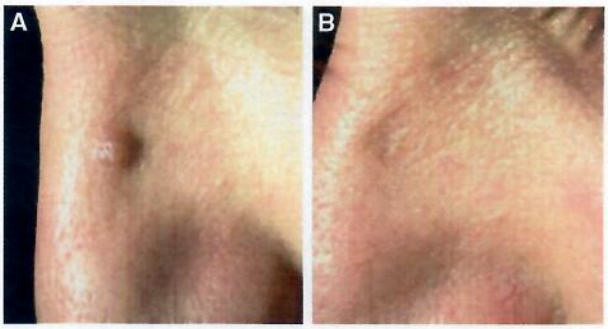

Figure 13: PG at the nose (A) before and (B) after laser treatment with less favorable cosmetic result.

70% of the cases (n=99), the argon ion laser in 30% of the cases (n=43).

In the argon ion-laser group recurrences were found in 63% (n=27) of the cases, which were either treated by repeated argon ion-laser treatments or second Nd:YAG-laser treatment (Figure 15). In PG lesions treated primarily with the Nd:YAG laser, 7% (n=7) required a second treatment during the same period (Figure 16).

Single successful treatment was achieved with all treatment modalities of Nd:YAG laser, with the technique used being adopted to size and other individual findings. All seven recurrences occurred in the "coagulation *in situ*" group, none were seen in the "radical removal" group.

3.2.2 Period 2005–2013

Between 2005 and 2013 a total of 312 PG lesions were treated, 94% of those (n=293) with the Nd:YAG laser and 6% (n=19) with either the KTP laser (n=16), the argon ion laser (n=1), the FPDL (n=1) or a combination of FPDL with a pulsed Nd:YAG laser (n=1). Once again the primarily response rate was higher with the Nd:YAG laser (96%, n=282). A second treatment was necessary in only 4% of the cases (n=11) independent of the used laser technique ("coagulation *in situ*" or "radical removal") (Figure 17).

In the largest group treated with other visible lasers (coagulation *in situ*), the KTP group, the primary success rate was 62% (n=10) and the recurrence rate was 38% (n=6).

4 Discussion

Patient's experience PG being an acute problem. After an individually variable period they may show up for

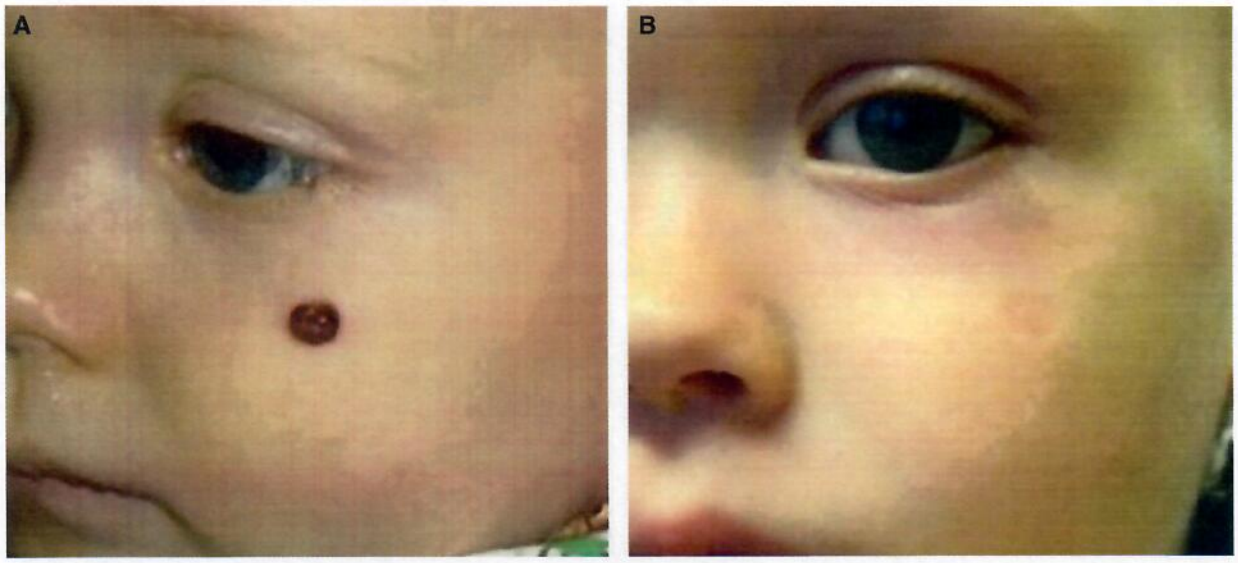

Figure 14: PG at the left cheek (A) before and (B) after laser treatment with less favorable cosmetic result.

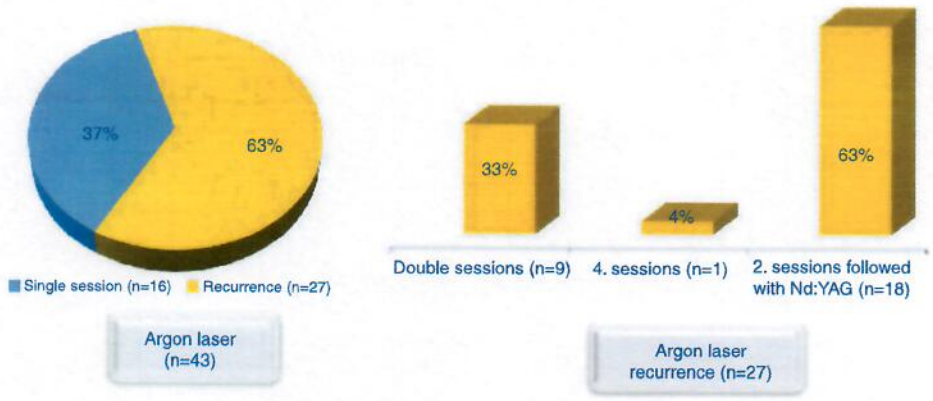

Figure 15: In the period of 2000–2004, recurrences were seen in 63% (n=27) of argon ion-laser treatments of PGs.

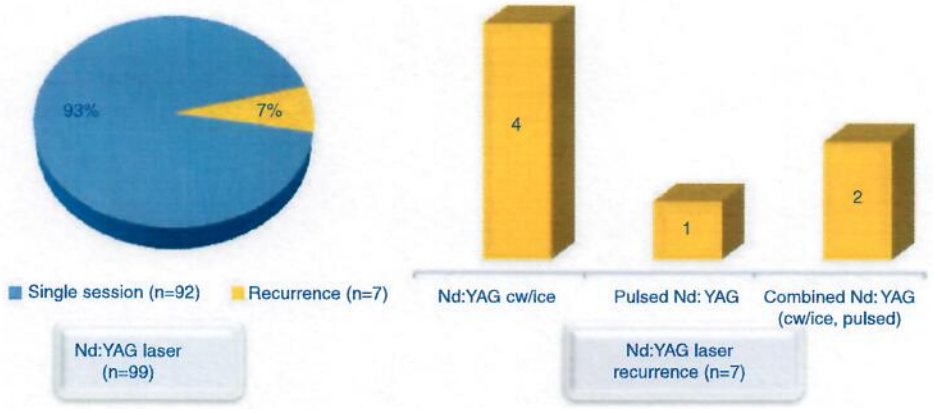

Figure 16: In the period of 2000–2004, recurrences were seen in 7% (n=7) of Nd:YAG-laser treatments of PG (all performed by "coagulation *in situ*" technique).

treatment as early spontaneous involution in PG is rare and usually complications occur. After treatment unfortunately only a limited number shows up for control, either being satisfied with the result of treatment or not. But why one should show up for a control if the problem has obviously vanished in an acute disease? In this retrospective cohort study, 199 patients could be evaluated with regard to the clinical outcome of the treatments by two blinded therapy evaluators on the base of clinical photographs and 450 patients where included for result-independent data analysis.

As to our knowledge this is the largest single institution study on this topic [5]. Thus, epidemiologic aspects may be of special interest but regarding patient selection a possible bias towards skin lesions, children and female patients must be taken into account as pediatricians represent a greater number of referring colleagues and other larger groups are referring gynecologists and dermatologists. On the other hand usually those disciplines and maxillofacial surgeons are confronted with PGs. This also could lead to a bias by selection of the cohort with localizations at the head and neck by the referring practitioners. We have seen only few mucosal lesions, no significant group to be mentioned separately. Other PGs may have been treated "in house" in other clinics. Standard therapy employs shave excision and cautery [6].

Color-coded duplex sonography is essential during clinical examination of patients with vascular lesions as it enables 3-D view of structure and metric measurements and provides functional information about perfusion of vascular tumors and malformations. At our clinic, CCDS was used in every first examination and controls of vascular lesions as PG, IH and others as routine clinical method.

During the analyzed period several application techniques have been used. Some other authors employed bare fiber applications too [7]. The bare fiber is used either as emitter of a divergent laser beam (if freshly cleaved and in

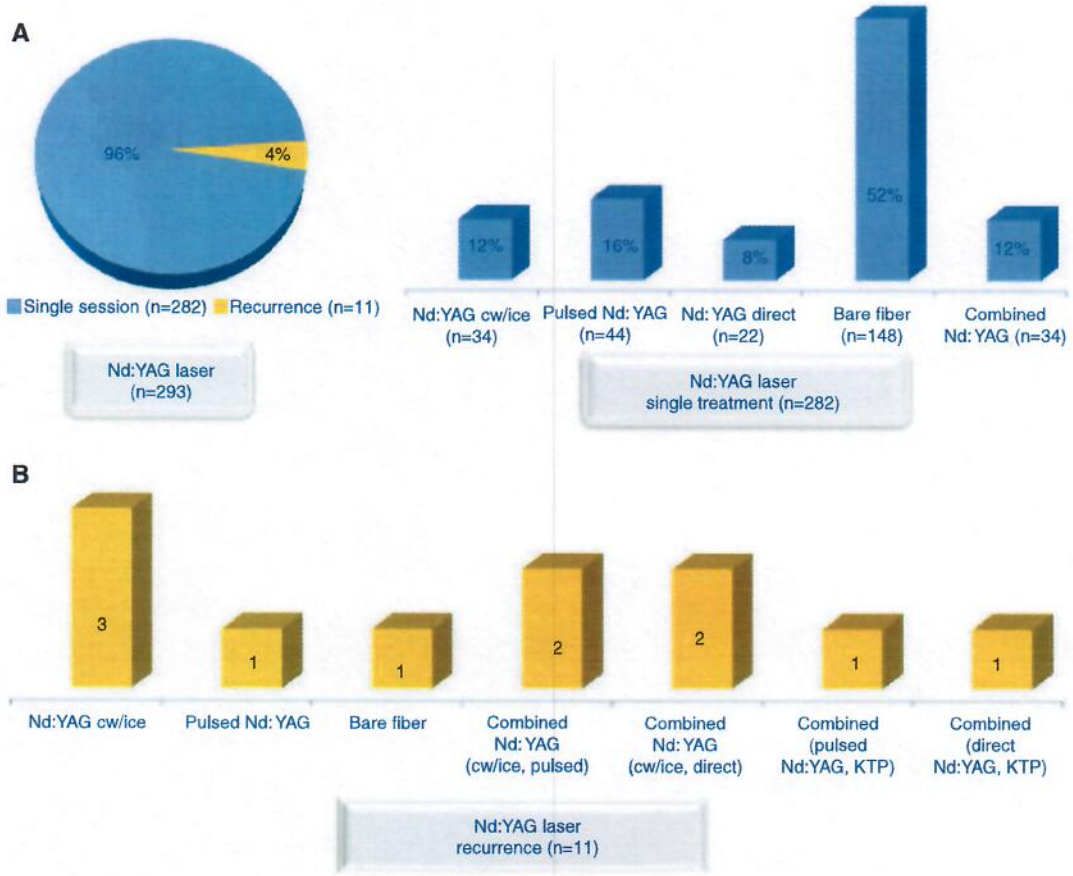

Figure 17: Therapy results in the period 2005–2013. (A) As from 2005, a reduced recurrence rate of 4% (n=11) for Nd:YAG-laser treatments of PGs was found. Most PG treatments were performed with the bare fiber (radical removal). (B) Recurrences occurred in all laser treatment types.

non-contact or impression) or scalpel blade (with pre-carbonized end in contact with the tissue). Thus, with one bare fiber the surgeon is able to change between coagulation and cutting instantly. Usually, the bare fiber comes with a "SMA 905" connector, which may be adapted to almost all lasers, and is held by a handpiece incorporating the fiber; thus providing steerability and grip. This handpiece made of steel is a simple surgical tool, inexpensive and autoclavable for many uses. Other near-infrared wavelengths around 1064 nm may gain similar results (e.g. 980 nm, 940 nm or 1320 nm), but we did not investigate their use in this study. Techniques employing the bare fiber proved to be most sufficient and with a good clinical outcome in this study. Usually general anesthesia is required in children, local anesthesia is sufficient in adults.

Continuous Nd:YAG lasers are of surgical use and differ from pulsed Nd:YAG lasers. They are known to rather "burn it down" as for selective action. They are not common in the US but still frequently used in the European Union. In our clinic, cw Nd:YAG lasers are used as important option in the therapeutic spectrum of treatment of IH.

Infantile hemangiomas are common benign vascular tumors of early infancy and will usually regress spontaneously. Some disappear completely others require close controls and about 5% have to be treated to avoid complications. Nd:YAG laser treatment of IH aims to induce regression, not to remove. As the direct exposure of skin with the beam of a cw Nd:YAG laser leads to scarring a very effective and safe cooling is mandatory. Transparent ice cubes in close contact with the lesion and sometimes even compressing the surface in order to reduce superficial blood content (and absorption) are the standard method for cooling in IH [8].

As effective this method is for IH our data disclose its relative failure in PG treatment. The "trans-ice exposure" method let to a greater number of recurrences in PG as other application techniques of the Nd:YAG laser. As PG being more aggressively growing and regression is not common a more aggressive approach may be needed.

Pulsed Nd:YAG lasers aim for rather selective action on vessels, but are less selective as FPDL or KTP lasers [9]. This may represent an advantage in larger vessels as penetration of the beam into tissues and blood in particular is deeper as in the visible (VIS) wavelength range while there is still a preferred absorption in blood vessels. Combinations of pulsed sequential emissions with different wavelengths (VIS and infrared) may be used to increase the absorption of infrared beams.

Pulsed Nd:YAG lasers were used in outpatient treatments in this study in order to treat rather sessile and small to medium-sized PG lesions. Endpoint was blanching and shrinking to epidermal level. This represents another bias in this study as possible recurrences after pulsed treatment may have been tolerated in smaller lesions and repeated treatments were accepted, in order to avoid general anesthesia in children.

A relatively high recurrence rate of 38% (n=6) was observed in the first group using the KTP laser (532 nm). Only the argon ion-laser treatment (514 nm) showed more recurrences (63%, n=27) followed by a second treatment. Some positive reports about FPDL treatment of PGs have been published [10, 11], our own experience using this lasers in PG treatment is limited.

Usually the lesions were small or medium-sized, but nevertheless the high absorption in hemoglobin restricts deeper penetration and deeper or larger vessels may not be sealed and cause recurrences. With regard to these results we do not recommend the use of highly selective lasers for treatment of PGs. Additionally the carbon dioxide-laser resection has been reported successfully [12, 13], but as its capability to handle bleeding complications is limited we did not include this option into our clinical use.

The most striking result was the absence of any complications such as secondary bleeding or secondary infection. One reason may be found in the consequent application of PVP-iodine gel and plaster dressing for 24 h after treatment.

Gender distribution equals on the first view. Closer analysis using age correlation revealed a predominance of male patients until an age of 20 years and a preferred occurrence in females after 20 years of age. This is in accordance with epidemiological data reported earlier [5].

In total 25% (n=91) of the PGs in the head & neck region were located at the eyelid followed by the lips and the nose (11% each, Figure 8). This was a new finding as no data in literature about local distribution in the head and neck e.g. eye region exists. Functional results are of high importance in this particular region. All of those PGs where removed completely and function was restituted in 100%, some texture changes were observed.

5 Conclusion

Laser treatment using pulsed or bare fiber Nd:YAG laser has proved to be successful in PG treatment with no relevant side effects or complications. Scarring is observed in only 40% and thus less compared with shave excision and cautery. Hence, we suggest to include Nd:YAG lasers into the options of first-line therapy for pyogenic granuloma.

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