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In Growing Toenail Treatment using Carbon Dioxide Laser

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Abstract: Background: An ingrowing toenail is a common problem affecting mainly adolescents and young adults, with a male predominance of 3:1. The disorder generally occurs in big toes. It is painful and often chronic and it affects work and social activities. Most patients initially complain of pain and later discharge, infection and difficulty in walking occur. **The Objectives**: The purpose of the study was to evaluate the efficacy and safety of (10600nm) CO_2 laser in the treatment of ingrowing toe nail. **Patients, Materials & Methods:** This study was done in laser medicine research clinics from July 2013 to the end of December 2013; 10 patients including 7(70%) males and 3 (30%) females with age ranging from 18 years to 70 years with mean age of 44 years old. The details of the procedure were explained verbally to the patients. Patients were examined and evaluated clinically and prepared for surgery. A CO2 continuous wave 1-40W laser emitted at 10600 nm; the laser was delivered via an articulated arm. Laser was used for cutting the nail and vaporization of the underlying germinal layer (matrix). **Results**: The preliminary clinical findings included sufficient hemostasis, coagulation properties and precise incision margin with all of the surgical procedure. The postoperative advantages, i.e., lack of pain, bleeding, infection and, recurrence the good wound healing and overall satisfaction were observed in the clinical application of laser in treatment of ingrowing toenail. **Conclusion**: The clinical application of the CO_2 (10600 nm) laser in surgical procedures prove to be of beneficial effect for daily practice. It can be considered practical, effective and easy to use, and it offers a safe, acceptable, and impressive alternative for conventional techniques of surgical treatment of in growing toenail.

Introduction

In growing toenail is a common problem affecting mainly adolescents and young adults. The disorder generally occurs in big toes. An ingrowing toenail occurs when the edges or corners of a toenail grow into the soft tissue of the toe - the soft skin adjacent to the nail - and pierces it. It is painful and often chronic and it affects work and social activities. This condition has three different stages mild, moderate and severe **as shown in Figure (1)**. Most patients initially complain of pain later drainage, infection and difficulty in walking occur. There are several interventions for the treatment of in growing toenails, It is not clear which interventions give the best results when looking at recurrence, healing time, postoperative complications (e.g. infection, bleeding), and satisfaction. Although there is no consensus about a standard first-choice treatment, most physicians prefer surgical treatment over non-surgical (conservative) treatment (Heidelbaugh JJ, Lee H. 2009).Treatment of ingrowing toe nail with a carbon dioxide (CO_2) laser has been

reported since 1980 (Apfelberg DB; et al. 1984). It is used to cut the nail and cauterization and vaporization of the matrix which is the germinal layer. CO_2 laser is very useful for skin and nail surgery; it allows the incision or vaporization of tissues, it coagulates small vessels and avoids bleeding in nail surgery, it really reduces the operative time; (Takahashi M,. 2000) it is very fast and easy to destroy a granulation tissue, to incise/vaporize the nail plate and the hypertrophic nail fold. The selective destruction of the lateral horn of the matrix is carried out by defocusing the laser beam, In case of infection; the CO_2 laser sterilizes the wound. What is required for the laser is to prevent recurrence and make patient satisfy with acceptable shape and healthy foot. (Serour F. 2002)

A - Stage I (mild) **B- Stage II (moderate)** **C -Stage III (severe)**

Fig. (1): The three stages of in growing toe nail

Patients, Materials and Methods: Ten patients with different gender (7) male (70%) and (3) females (30%), patients ages ranged from (18)-(70) years old with a mean of 44years old. Different stages of ingrowing toenail participated in this study: 7(70%)patients with stage I, two (20%)patients with stage II,one (10%)patient with stage III. Each patient was getting ready for the procedure after full explanation and discussion regarding the nature of the procedure, the possible advantages and +disadvantages, and complications expected. At the conclusion of discussion, each patient was asked to sign an "informed consent" indicating his agreement.

Inclusive criteria:
All patients with any of the three stages of disease with any age are included in this study.**)**

Table (1): Stages of the disease

Stage	Signs and symptoms	Patients
I	Erythema, slight edema and pain when pressure is applied to the lateral nail fold.	7 (70%)
II	Increased stage 1 symptoms, drainage and infection.	2 (20%)
III	Magnified stage 1 symptoms, presence of granulation tissue and lateral wall hypertrophy.	1 (10%)

Exclusive criteria:
Patients with uncontrolled diabetes because need a hospital admission to control their diabetes , ischemic hearts disease with history less than 6 months because they might not tolerate local anesthesia or need hospital admission for observation and severe infections and avulsed nail because this case needs exclusive criteria to extraction of nail .
Clinical assessment: All patients were examined clinically before treatment; digital photographs were taken before and immediately after treatment, 1 week, 2 week and 1 month after treatment for comparison. Before laser treatment questionnaire was put for the patient to help to assess and follow up the patient:
Name, age, sex, chief complaint, systematic review, drug history, past medical, surgical, laser history. History of photosensitive disease, eye problem, skin malignancy and duration of the lesion.

Materials: Equipment: it consists of a surgical set shown in Figure (3)and CO_2 Laser figure (4) The surgical set consists of surgical gloves , syringe 1ml filled with 2% percent lidocaine, sterile gauze sponges, povidone-iodine solution, scissors, two straight hemostats, sterile rubber band (used as tourniquet) and bandage.

Fig. (3) Surgical set

CO_2 Laser specifications

The device was made in Korea by

DAESHIN Company
The systems body is equipped with CO_2 laser tube., Wavelength of 10600nm infrared ray. Mode structure (divergence) TEM00., Distance of focus: F100 mm or F50 mm, Size of focus: 0.1mm at hand piece, Output against tissue cell can always be modulated within the following range , CW: 1-40W., PULSE: 1-40 W., Ultra pulse duration: 90µs- 900µs, Peak power at ultra pulse: 188 W- 315 W. Repeating time at ultra pulse 2ms- 500ms Operating mode :continuous wave ,normal dream pulse ,ultradream pulse and super dream pulse .

Fig. (4): CO_2 Laser specifications

Safety measures: In the present work, the laser employed is class IV laser which includes any continuous wave laser device with power outputs above 500mW.These types of laser can cause damage with direct intrabeam exposure and from specular or diffuse reflections. All personnel were asked to wear protective glasses appropriate to the procedure to eliminate the risk of eye damage. These glasses are designed with special wavelength and optical density for CO_2 laser. Eyes of the patient were covered with mops of cotton or gauze, taking into consideration the elimination of any reflecting materials, metals and polished plastic in the laser room. The smoke and vapor plume were carefully extracted using a vacuum system. This is necessary to minimize the hazards to the patient and staff as many types of infections can be present in the vapor of CO_2 laser.

Method:
After applying 10% of povidone iodine solution as an antiseptic, a digital nerve was blocked by infiltrations of the distal portion of the digit by local anesthesia (lidocaine (without epinephrine) 2% infiltration 1 cc medially and 1 cc laterally). Then a tourniquet was place (no more than 15 min) around the base of the digit, Safety precaution were applied through the use of the goggles for the patient and surgeon. With a continuous CO_2 laser on focus point started at 5 W and 7W, it was found that these power is low to cut the nail plate then (10W) was used and found it has a good enough power, the nail plate was incised about (4 mm from the edge) starting from nail free margin distally till nail root proximally

then by using a sterile forceps the affected part of the nail was avulsed and removed. This almost always shows a spike at the distal affected end of the nail strip. After remove this part of the nail the matrix was exposing. The affected horn of the matrix is selectively destroyed by defocusing the laser beam as shown in **Figure (5).** A dressing is applied after removing the tourniquet and was changed daily

Follows- up (Clinical Observation and Evaluation) Table (2).

All patients were examined in 3days, 1 wk, 2 wk, and 4 wk after surgery to assess pain, bleeding, edema, recurrence and overall satisfaction. In the follow-up appointments, clinical observations, assessments and documentation by digital photos were done by the operator during examination, in addition to the data collected from the questionnaire sheets including the patient's notes at the operation day and during follow upvisits.

Table (2) Patients follow-up

Patient No.	***Age***	***Gender***	***Stage***	***Follow up***															
				Pain				***Bleeding***				***infections***				***Recurrence***	***Overall satisfaction***			
				3dy	*1wk*	*2wk*	*4wk*	*3dy*	*1wk*	*2wk*	*4wk*	*3dy*	*1wk*	*2wk*	*4wk*	*4wk*	*3dy*	*1wk*	*2wk*	*4wk*
1	**24**	**male**	**I**	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*2*	*3*	*3*	*3*
2	**48**	**male**	**I**	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*3*	*3*	*3*	*3*
3	**65**	**male**	**I**	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*0*	*0*	*0*	*0*	*2*	*3*	*3*	*3*
4	**70**	**male**	**I**	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*3*	*3*	*3*	*3*
5	**45**	**female**	**II**	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*2*	*3*	*3*	*3*
6	**18**	**female**	**I**	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*3*	*3*	*3*	*3*
7	**43**	**male**	**III**	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*0*	*0*	*0*	*1*	*2*	*3*	*3*	*2*
8	**51**	**male**	**I**	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*3*	*3*	*3*	*3*
9	**56**	**male**	**II**	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*0*	*0*	*0*	*0*	*3*	*3*	*3*	*3*
10	**20**	**female**	**I**	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*3*	*3*	*3*	*3*

A **B**

Fig.(5) A-pre laser treatment- B- Post laser treatment

Results

Pain: only 1(10%) patient, the one with stage III, experienced mild pain during first three days postoperatively the one with stage III, no patient experience pain during one week, two weeks and four weeks postoperatively. So in this clinical study the surgical, procedure was well tolerated by all the patients. Figure (6)

Bleeding: After laser-treatments with release of tourniquet no bleeding were occur in all cases, which give us clear surgical field. Figure (6)

Infection: Three cases of mild infection were notice after treatment with laser and there was no need to take antibiotics postoperatively the infection subside within one week because the CO_2 laser sterilizes the wound. During the post-operative phase, the risk of infection is low. Figure (6)

Recurrence: In our cases, one case with stage III in which there was a growth of the nail within one month after treatment and this was due to technical error during the operation in which the laser did not reach the matrix germinal layer. Figure (6)

Overall Satisfaction: In general patients were comfortable and with no pain, either intra-operatively or post-operatively with no functional complications. They can walk postoperatively, except one patient with recurrence. Figure (6).

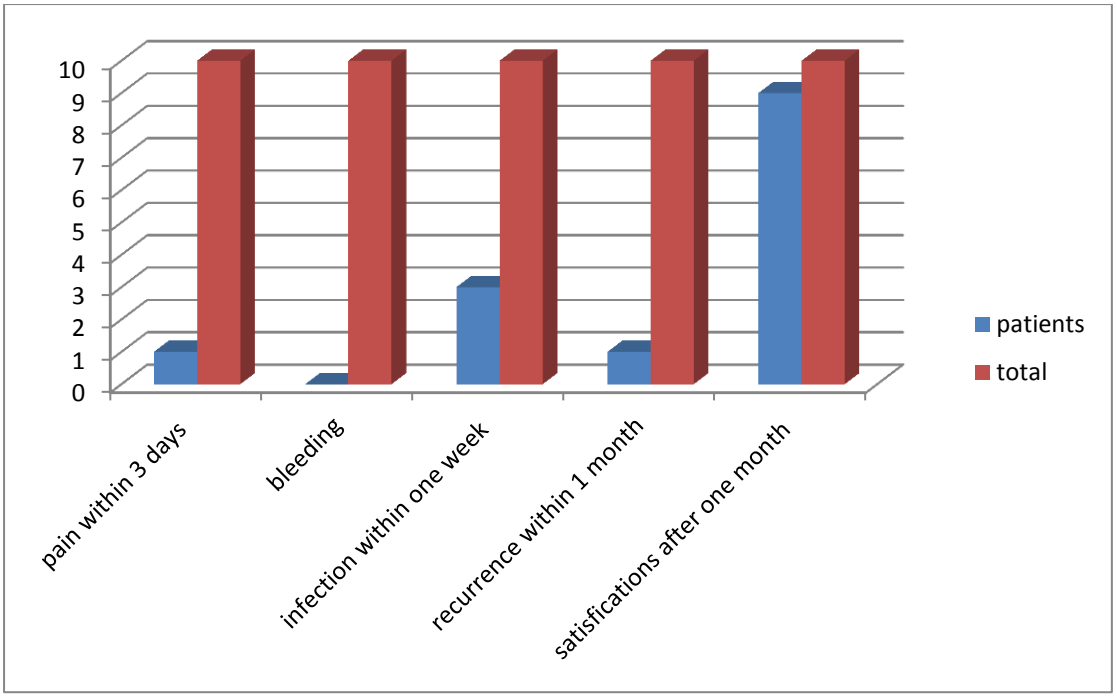

Fig. (6) Patients observation

pre laser treatment

pre laser treatment

after one month

after one month

Fig. (7): Pre and post laser treatment

Discussion

Laser treatment of ingrown toenails disease is a highly concentrated energy that generated laser beam with high temperature causing the rapid removal of granulation tissue, and destroy the nail bed germinal layer and restore the ipsilateral ingrown toenails. The ingrown toenails nail bed is destroyed so that it no longer cause ingrown toenails, curing the paronychia (Xu Shaoting 2005).

In this study, we used tourniquet during the operation but after the release of tourniquet there are no bleeding at all and the wound completely dry that's why the CO_2 laser is very useful for nail surgery; it allows the incision or vaporization of tissues, it coagulates small vessels and avoids bleeding, this was notice in Xu Shaoting et al and **Garden** JM et al.

In nail surgery, it really reduces the operating time. In this study maximum operating time was 10 minutes, it is very fast and easy to destroy a granulation tissue, to incise/vaporize the nail plate and the hypertrophic nail fold. The selective destruction of the matrix horn at the affected side is carried out by defocusing the laser beam (10W) by elevating the hand piece slowly, a very easy and rapid operation. Shortened operating time is due to minimal bleeding as its notice by Takahashi M, Narisawa Y et al. , P. André et al . , H. Tada.

In case of infection, the CO_2 laser sterilizes the wound. During the post-operative phase, the risk of infection is low. In this study only three case of infection was notice before treatment with laser and no need to take antibiotics postoperatively and it subside within one week, due to thermal effect of the CO_2 laser. It acts as antibiotics, so the infection is minimal as it is noticed by P Andre et al .

Immediate post-operative pain is less because the laser seals the sensory nerve endings, (it seal the exposed nerve endings), the pain less severe than after classical nail surgery. So laser treatment particularly useful in cases of severe in growing nails associated with hypertrophic fold of affected side, as it notice by Takahashi M, Narisawa Y et al. P. André et al . and H. Tada et al .

In this study only one case recurred was observed after one month of treatment of in growing toe nail by CO_2 laser which it include partial lateral nail cutting and extraction with lateral matrix horn vaporization.

The recurrent rates depend on surgical technique as it was noticed by A. Orenstein, O. Goldan, O. Weissman et al A comparison between CO_2 laser surgery with and without lateral fold vaporization for in growing toenails found the recurrence rate after resection of the nail segment and its nail bed alone was 37.5% whereas it dropped to 6.2% after additional lateral nail fold vaporization

Removal of the lateral nail without matricectomy results in recurrence of ingrown nail in 70% of patients (Siegle RJ, 1992). The entire nail plate should not be removed unless necessary to avoid the resulting large area of tender exposed nail bed (Daniel CR . 1992).

There are a lot of different surgical interventions without using laser. Almost every surgical intervention aims to remove the troublesome part of the nail and destroy the underlying matrix so that there is a small risk of recurrence. The techniques used nowadays are described by Zadikin. They include total nail avulsion combined with total surgical excision of the matrix the recurrent rate found to be 14 – 28%. (Shaath N; Shea J; 2005).

Matrix cauterization with phenol has a low recurrence rate of (0% to 11%) (Bostanci S; 2001) Complications arise from phenol cauterization to the matrix prompted surgeon to try another chemical agent, which is safer and also effective, sodium hydroxide is a slow – acting caustic agent, and its destructive effect depends on its concentration and duration of contact Sodium hydroxide causes an alkaline burn and liquefaction necrosis but not coagulation necrosis as in the case of phenol. This may be the reason that sodium hydroxide causes less post-operative drainage and faster healing (Bostanci S; 2007). In one study by Brown 50 cases had been treated by applying 10% sodium hydroxide for 20 – 25 second, he followed most of the patient and report a 2% re-growth of a spicule and the time for healing was approximately 10 days (Aksakal AB; 2001).

Conclusion

The clinical application of the CO_2 (10600 nm) laser in ingrowing toe nail considered to be practical, effective, easy to use, offers a safe, acceptable, and impressive alternative for conventional techniques of surgical treatment of in growing toenail.

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علاج الاظفر الناشز باستخدام ليزر ثنائي اوكسيد الكربون

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الخلاصة: المقدمه :الاظفر الناشز من المشاكل الشائعه التي تصيب المراهقين والشباب مع احتماليه للذكورأعلى من الاناث و بنسبه ثلاثه الى واحد ،الاصابة تحدث عادة في أصبع القدم الكبير وتكون مؤلمه جدا ومزمنه بحيث توثر على عمل ونشاط المريض ،معظم المرضى يعانون من الام حاده في البدايه تتفاقم الحاله الى التهاب وخروج للسوائل تصاحبها صعوبه في المشي . **الهدف من الدراسه**: تقييم كفاءه ليزر ثنائي اوكسيد الكاربون في علاج الاظفر الناشز. **طريقه الدراسه**: اجريت هذه الدراسة في العيادات الطبيه والبحثيه بمعهد الليزر للدراسات العليا من بدايه شهر تموز ولغايه نهايه شهر كانون الاول 2013 شملت الدراسه عشرة مرضى يعانون من الاظفر الناشز بواقع سبع ذكور وثلاث اناث تتراوح اعمارهم ما بين 18 سنه الى 70 سنه وبمعدل 44 سنه ،تفاصيل العمليه شرحت شفهيا للمرضى وتم فحصهم وتقيمهم سريريا ومن ثم تحضيرهم للتداخل الجراحي باستخدام ليزر ثنائي اوكسيد الكاربون وبقوه 10 واط وطول موجي 10600 نانو ميتر ،الليزر استخدم لقطع الاظفر مع كوي الطبقه المولده للاظفر والتي تدعى المصفوفه . **النتائج** :اثبتت النتائج السريريه على القدره العاليه لليزر ثنائي اوكسيد الكاربون على ايقاف النزيف والقطع الدقيق خلال التداخل الجراحي كما من مميزاته عدم النزف والالم والوذمه ومنع رجوع الاظفر الناشز مع التأم جيد للجرح ،سجل معظم المرضى رضى عالي في استخدام الليزر في عمليه الاظفر الناشز . **الأستنتاج**:التطبيق السريري لليزر ثنائي اوكسيد الكاربون في العمليات الجراحيه يمكن اعتباره عملي وفعال وسهل الاستعمال وامين ومقبول وبديل للعمليات التقليديه للأظفر الناشز .