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Interstitial Photocoagulation of Low Anal Fistula using 810 nm Diode Laser: *Prospective Study*

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Abstract:

Background: Many conservative sphincter-preserving procedures had been described to be effective in healing of anal fistula without excision or de roofing.

Objective: To verify the outcome of mere photocoagulation of the fistula tract on healing of low anal fistula.

Materials and Methods: Using 810nm diode laser, the tracts of low anal fistulae in a cohorts of six male patients (mean age of 32 yr) had been photocoagulated by retrograde application of laser light through an orb tip optical fiber threaded in to the tract. Swabs for culture and sensitivity testing were obtained before and after laser application. Patients were followed up regularly to announce fistula healing.

Results: Mean laser exposure time was 6.6 min., mean operative time was 19 min., mean hospital stay was 5.9 hrs and mean fistula closure time was 7.7 days. The negative immediate post laser exposure swabs indicate that laser may have a bacteria killing power. There were no evidences of incontinence or recurrence within the mean follow up period of 9 weeks. The feasibility of using the selected laser and accessory was excellent. The basic laser-tissue interaction was thermal photocoagulation without carbonization.

Conclusions and Recommendations: Mere photocoagulation of the fistula tract may heal a low anal fistula. Within the chosen parameters of laser application, there was no evidence of damage to the anal sphincter. It is recommended that larger number of cases to be done to allow for proper statistical analysis. High, complicated, and recurrent cases may be included. A longer follow up period to assess intermediate and long term recurrences is recommended.

Introduction

The aim of treatment of anal fistula is to eradicate fistulous tract whilst preserving sphincter integrity and function (Russell, 2000). With traditional fistulectomy or fistulotomy, and especially in management of high and more complex fistulae, there is always a possibility of excessive sphincter damage and incontinence (Hawley, 1996).

Many methods had been employed to aid healing and to minimize trauma to the sphincter. They are mainly directed towards eradication of the epithelialised fistula tract being the main reason of persistence and chronicity of any anal fistula (Lunnis *et al*., 1995).

With the introduction of laser in general surgical practice (Dixon, 1988), and the recent better understanding of photobiology and laser tissue interactions (Parrish and Wilson, 1991), it happened that laser became a useful tool in the hands of a competent surgeon. One aspect at which laser has been useful is for cutting and coagulation purposes in the surgical treatment of different peri anal conditions (Gregory *et al*., 1991).

The present paper verifies the possibility of healing of a low peri anal fistula by mere

photocoagulation of its tract without fistulectomy or fistulotomy.

Materials and Methods

The study was performed between December 2003 and June 2004. A cohort of six patients with a provisional diagnosis of low type anal fistula was selected for this study. They were males, average age of 32 yr (range of 24 - 42 yr).

The average duration between symptoms and presentation was 7 months (range of 3-12 months). A single external fistula opening was lying at variable positions and distances from the anal verge. The average distance was 3.25 cm (range of 2.5 - 4 cm). Anal digital examination can identify a palpable internal opening in only four patients (Table 1).

In only one patient a significant past medical history of diabetes mellitus, already controlled on oral hypoglycemic therapy, was identified.

The laser system used was a "Diomed 15"surgical diode laser. It essentially incorporate a class IV GaAlAs (Gallium Aluminum Arsenide) diode laser emitting at a wavelength range of 790-830 nm (i.e., near IR) with a power output at laser aperture ranging from 0.5-15 watts. It can be operated at a continuous or pulsed mode. The aiming beam is a visible diode 635-660 nm (red beam) with a power of 4 mW (class IIIa diode laser) at laser aperture.

The accessory used for performing interstitial photocoagulation was an Orb tip optical fiber with a tip size of 800um. The laser energy is displaced outwards from the forward curvature of the fiber, which has the advantage of coagulating larger tissue surface.

Table 1: Details of six patients

Pt. No	Age (yr)	Period (month)	Past History	Ext. Opening	PR. Int. opening
1	28	10	Negative	Ant. 3.5 cm from anal verge	+
2	42	7	Diabetes M.	Post. 3 cm from anal verge	+
3	32	4	Negative	Post. 2.5 cm from anal verge	-
4	35	12	Negative	Ant. 4 cm from anal verge	+
5	24	3	Negative	Ant. 3 cm from anal verge	-
6	32	6	Negative	Ant. 3.5 cm from anal verge	+

Preliminary Study

An in vitro experiment was designed to pre fix parameters for interstitial coagulation of an anal fistula. The anal region and part of the buttocks of a "sheep" were obtained. With the use of a blunt probe, multiple tracts were created and threaded with surgical (No. 2) silk suture, which was utilized to railroad the optical fiber along these "false fistulae". Interstitial coagulation of these tracts has been performed using different laser powers at different rates of retrograde application. Each tract was laid open (guided by the suture that is left threaded in side of it) after the end of each application, and direct careful inspection of the treated tissue is performed. The aim of the experiment was to obtain a satisfactory coagulation of tissue without charring and carbonization. The indicator of a satisfactory interstitial coagulation was a change in the color of the tissue to yellow-brown with minimum carbonization. The different parameters applied are illustrated in Table 2.

Table 2: Different laser parameters applied

Tract	Power density (W/cm^2)	Rate (cm/min)
1	1591.5	0.1
2	1591.5	0.5
3	1192	0.2
4	1192	0.5
5	994	0.1
6	994	0.5

Operative Procedure

Under general anesthesia and in Lithotomy position, the operative field was mopped with 4% Hibitan solution. Gentle and gradual

dilatation of the anal verge up to four fingers performed, the internal opening of the fistula was identified by digital examination. A bare ends stainless steel metallic fistula probe was used to negotiate the whole fistula tract (Fig. 1).

Fig. 1: Fistula tract completely probed

The rear end of the probe was scratched for about half a centimeter to hold a silk suture of (oo) caliber tied on it. On pulling the probe out of the anal verge, the silk suture was threaded along the whole fistula tract. At this point the suture was untied and the probe removed from the operative field. The end of the silk suture emerging from the external fistula opening was tied very gently to the Orb tip of the optical fiber. By gentle steady pull on the silk end using the left hand, the right hand guided the optical fiber tip to negotiate the whole fistula tract (Fig. 2).

Fig. 2: Optical fiber threaded along fistula tract

At this point, the optical fiber was pulled "slowly and gently" in a retrograde manner at a rate of 0.5 cm./min applying continuous power of 5W (a power density of 994 W/cm^2). The procedure continued at this rate until the whole optical fiber was out of the fistula except for the Orb tip which was left for extra 10 seconds at the external opening prior to pulling it out terminating the procedure (Figs. 3, 4 and 5).

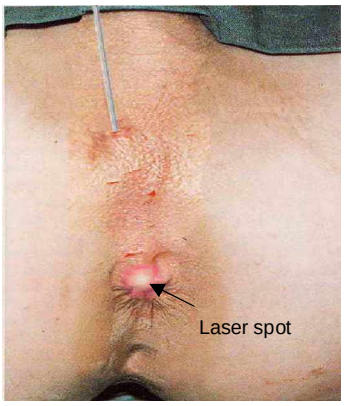

Fig. 3: Start of photocoagulation of the tract

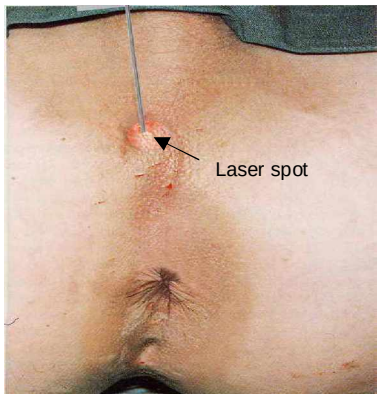

Fig. 4: Photocoagulation of the external opening

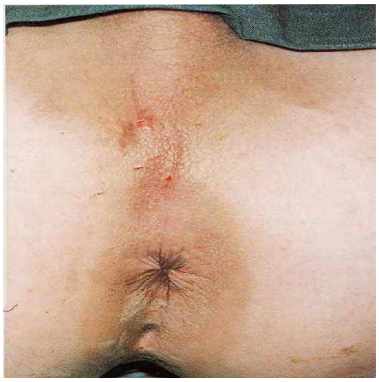

Fig. 5: Photocoagulation of the anal fistula completed

With the mentioned parameters, the total exposure time for each patient was entirely dependent on the length of the fistula treated (Table 3). The mean exposure time was 6.6 min. (range of 5.17 - 8.17 min.).

Table 3: Laser exposure time for each fistula

Patient number	Fistula length (cm)	Exposure time (min.)*
1	3.5	7.17
2	3	6.17
3	2.5	5.17
4	4	8.17
5	3	6.17
6	3.5	7.17

* An extra 10 seconds (0.17 min) of exposure to the external opining of each fistula.

At the conclusion of the procedure, swabs for cultures were taken from the last millimeters of the tract through the external opening. A small dry dressing was put on the external fistula opening and the patient transferred to the ward after full recovery from general anesthesia. Neither antibiotics nor analgesics were prescribed post operatively. Patients were discharged few hours later. On discharge, they were only prescribed a mild analgesic in the form of Paracetamol 500mg tablets to be taken on need. All of them had been informed to report twice in the first week after the procedure, and then once weekly for at least 5 weeks. Follow up was terminated at 31 May 2004

Evaluation Parameters

Parameters that had been considered to evaluate the present results are the followings; the ease to operate and practicality of the laser used (feasibility), the mean operative time, the mean hospital stay, the results of the culture of the pre operative samples compared with the results of culture of the immediate post operative samples, the assessment of post operative pain, the occurrence of postoperative incontinence and the time needed for the fistula to close.

Results

The results of the preliminary work, to choose a suitable parameter for interstitial coagulation of anal fistula are presented in Table 4. At power of 4 W and rate of 0.1 cm/min only slight pale yellow changes noticed (minimal coagulation), accordingly, a power of 5 W applied in continuous mode and at a rate of 0.5cm/min was considered safe for purpose of coagulation of the fistula tract, that is why it had been chosen.

Table 4: Results of applying different laser parameters

Tract	Power (W)	Rate (cm/min)	Result
1	8	0.1	Sever charring and carbonization.
2	8	0.5	Moderate charring and carbonization.
3	6	0.2	Carbonization of tissue still noted.
4	6	0.5	Deep-brown color with multiple carbonization points.
5	5	0.1	Deep-brown color with scattered carbonization points.
6	5	0.5	Brown to deep yellow color with no carbonization effect.

The results of the assessment of the evaluation parameters are presented in Table 5. Operative time was considered from the moment of initial fistula probing till the termination of laser delivery to the tissue. The mean operative time was 19 min. (range of 15-26 min.). The mean hospital stay from the time of admission till discharge was 5.9 hrs (range of 5-8 hrs). Evaluation of the postoperative pain was done in the follow- up period. Four patients admit no pain. Only two patients reported occasional need for a painkiller. No patient complained of incontinence anytime during postoperative period.

Pre-operative swabs obtained from external fistula discharge were all positive to different types of organisms including Escherichia coli, aerobic and anaerobic streptococci, Bacteroids, and staphylococci. The results of swabs taken immediately after the termination of laser procedure were negative for microorganisms except for the one case of Diabetic patient where his culture result was positive for aerobic streptococci.

Follow up was conducted to assess the time needed for healing and closure of the fistula. The disappearance of the discharge and closure of the fistula were considered as signs of healing. The

Table 5: Results of evaluation parameters in 6 patients

No	Date of operation	Operative time (min.)	Hospital stay (hrs)	Preop. Culture	Postop. Culture	Fistula closure (days)	Postop pain*	Follow up (wks)
1	24 Jan 2004	26	8	+	--	6	--	12
2	14 Feb 2004	25	6	+	+	14	+	14
3	28 Feb 2004	18	6	+	--	7	--	10
4	13 Mar 2004	20	5	+	--	5	+	6
5	27 Apr 2004	15	5	+	--	8	--	8
6	10 Apr 2004	15	5	+	--	6	--	3

* **(--)** No pain; (+) mild; (++) moderate; (+++) sever postoperative pain.

mean time for closure of the fistulae was 7.7 days (range of 5- 14 days). The follow up period could only assess the short-term results of the treatment. Intermediate and long-term recurrences need a longer follow up period to Asses. Recurrence is announced when the fistula start discharging again after being closed. There were no recurrences reported within the follow up period. The mean follow up period was 9 weeks (range of 3-14 weeks). No patient was lost to follow up except for the last patient who reports for three weeks only. Along the follow up period mentioned, no gross changes were noted in the overlying skin along the coagulated tract and palpation of the area detected no abnormalities in the form of cotractures, hardness or parasthesia.

The diode laser was found easy to use in all cases. The optical fiber was easy to clean and re sterilized for re-use. No complications were associated with the operative procedure except for the only accident of brakeage of the optical fiber inside the fistula tract (happened during the first operative procedure). It was easy to manage since both ends can be easily pulled out. The procedure was then repeated.

Due to the small number of procedures performed and evaluated, no statistical analysis of the data was accomplished.

Discussion

The traditional treatment for an anal fistula is the complete destruction or removal of the fistula tract. Conservative approaches are mainly concerned with sphincter preservation.

The procedure described in this work is an "operative sphincter preserving" procedure. It cannot be considered as an alternative to the "non-operative" sphincter-preserving management of anal fistula advocated in pediatric age group. In this method, management includes mainly antibiotic therapy along with observation awaiting spontaneous closure of the fistula. The method was described as safe, non-invasive, and effective (Rosen *et al.*, 2000). Anyway, it is not applicable to adult anal fistula where epithilialization of the tract and "walling off" by fibrosis prevent spontaneous closure (Philips, 1996).

Other sphincter preserving procedures described for complicated high type anal fistula, are not essentially "conservative" since fistulotomy or fistulectomy are essential part of the procedure. This entails longer operative time, longer hospital stay, more postoperative pain, longer time for fistula closure, and in case of recurrence, surgery will be a difficult task and the possibility of sphincter damage is higher (Hidaca *et al.*, 1997). The presumption that a protective proximal colostomy may heal an anal fistula with out excision of the tract is questionable (Cox *et al.*, 1997). Fistulectomy combined with closure of the excised tract by first intention had also been described. The result of this "invasive" approach is not much different than conventional procedure of fistulectomy or fistulotomy except for a relatively shorter fistula healing time. The occurrence of dehiscence of distal tract elongated fistula-healing time (Toccaceeli *et al.*, 1997).

A prominent conservative approach that had been described as being successful in healing both primary and recurrent anal fistulae is the application of fibrin glue adhesive inside the tract (Sentovich, 2001). After curettage of the tract, fibrin glue is injected in to the tract until adhesive is seen coming out of the other opining. The operative time is relatively longer, but a shorter hospital stay, absent postoperative pain, and shorter healing time were recorded. Successful healing had been seen in up to 85% when used on all fistulae and in 60% of recurrent fistulae. Most treatment failures occur within the first three months (i.e., a short-term recurrence) (Venkatesh and Ramanujam, 1999).

Comparing the results of photocoagulation of the fistula tract (using laser) with the results of the above mentioned conservative approaches shows that, with laser use, operative time was shorter, minimal postoperative pain, shorter hospital stay, and a quicker return to work were reported. Fistula closure time again was short. These results match those for fibrin glue application except for fistula closure time, which cannot be compared because, in fact, there is an immediate closure of the fistula with fibrin glue application. The short-term recurrence rate of photocoagulation was comparable with that for all the methods described.

The "presumed" bacteria "killing power" of laser was tested. Cultures of swabs taken from the coagulated tracts were negative to microorganisms except in the only case of diabetic patient. These results matches those described in the littérateur and may indicate that laser can be a practical "sterilizing surgical tool" for its immediate bacteria killing power (Makowiec and Jehle, 1997). Coagulation can block blood vessels and prevent spreading of infection. The high temperature produced has enough ability to directly kill the bacteria that commonly inhabit the fistula tract. It is obvious that this "killing power" is still dependent on the number of bacterial population. The higher the number the less efficient this power is (Makowiec and Jehle, 1997). Diabetics tend to have mixed infection and higher bacterial population than non-diabetics, which explains the positive cultures obtained in spite of laser application.

The follow up period in this study can only assess the short-term results of this procedure. According to the criteria for "fistula closure" (Ratto *et al.*, 2000), there were no recurrences within the follow up period. To assess intermediate and long term recurrence, a longer follow up period (up to 2 years) is needed.

The reasons behind selection of cases of low anal fistula for this procedure were the availability compared with cases of complicated, high and recurrent anal fistulae, in addition, It is the operator opinion that it would be unwise to select complicated cases of high or recurrent anal fistulae because the effect of laser photocoagulation of the fistula tract need to be verified on cases were the possibility of uncontrolled damage to the sphincter is remote.

Selection of the diode laser for this procedure was dependent on the availability, portability, and applicability of the optical fiber. The Orb tip optical fiber was useful since laser energy is displayed outwards from the forward curvature of the tip. The amount of laser energy deposited in the tissue was directly related to the length of the fistula tract treated. At the fixed rate of retrograde application and the fixed power chosen, the longer the fistula tract the more the exposure time and the more the laser energy deposited in the treatment site. An extra 10 sec of laser application to the external opining was necessary to coagulate the pouting granulation tissue, thus encouraged healing and closure of the external opening. It seems that at the parameters chosen, coagulation of a well-formed fistula tract is safe, with no apparent damage to the nearby sphincter muscles. None of the patients in the study complained of postoperative incontinence.

Because of absence of gross changes in the area treated, it seems that nothing precludes repeating the procedure or resorting to any of the conventional methods in case of failure and recurrence. The parameters mentioned in the study are definitely reproducible in any future study with or without modifications.

Safety measures were applied easily and enough goggles were always available to the attendant during the procedure. No accident regarding laser safety was recorded.

Conclusions and Recommendations

It may be possible to heal a low anal fistula tract by mere photocoagulation of the tract. Healing and closure of the fistula tract may be attributed to the coagulative destructive effect of the laser coupled with its bacteria killing power. Within the chosen parameters for application, there was no evidence of damage to the anal

sphincter. The procedure can be repeated in case of failure and its application dose not precludes the application of any other conventional procedure. The Intraluminal application of fibrin glue may compete with interstitial photocoagulation of the fistula tract.

It is recommended that larger number of cases need to be done to establish a statistical analysis. Results need to be verified against control cases. Longer follow up period to assess intermediate and long term recurrences is recommended. High type, complicated and recurrent anal fistula cases should be included in any future study.

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دراسة أستباقية للتخثير الضوئي لباطن قناة ناسور المخرج بأستخدام ليزر الدايود ذي الطول الموجي 810 نانومتر

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الخلاصة إن الطريقة التقليدية لعلاج ناسور المخرج هي استئصال قناة الناسور كليا أو فتح سقف هذه القناة انتظاراً لشفائها . هذه الدراسة تحقق في نتائج استخدام طريقة التخثير الضوئي المجرد لقناة الناسور دون استئصالها أو فتح سقفها وذلك من خلال تسليط ضوء الليزر تراجعيا داخل باطن القناة باستخدام الليف الضوئي المغذى من قبل ليزر الدايود ذي الطول الموجي 810 نانومتر . تم اختيار عصبة من ستة مرضى من الرجال متوسط أعمارهم 32 عاما ويعانون من ناسور المقعد واطئ المستوى لغرض إستخدام هذه الطريقة . كان متوسط المسافة بين الفتحة

الخارجية للناسور و بين المخرج هو 3.25 سم وفي مواقع مختلفة حول فتحة المخرج تم اخذ نماذج للزرع الجرثومي من قناة الناسور قبل البدء بالتخثير الضوئي . أجريت العملية تحت التخدير العام وكان متوسط الزمن اللازم لأجراء العملية هو 19 دقيقة ومتوسط مدة التعرض لشعاع الليزر هو 6.5 دقيقة . أظهرت النتائج أن الزمن اللازم لأجراء العملية ومدة رقود المريض في المستشفى بالطريقة الحالية أقصر من الطريقة التقليدية ، مع وقت اقصر لشفاء الناسور وألم طفيف أو معدوم بعد العملية . أن النتائج السلبية للزرع الجرثومي التي ظهرت بعد إتمام العملية مقارنة بالنتائج الإيجابية للزرع الجرثومي قبل إجراء العملية تشير إلى أن شعاع الليزر قد تكون له قابلية قتل للبكتريا . ولم يظهر دليل ضمن مدة المتابعة ومتوسطها 9 أسابيع على حدوث عدم سيطرة على فتحة المخرج أو حالة رجوع للناسور المعالج . لقد كانت إمكانية تطبيق هذه الطريقة ممتازة باستخدام الليف الضوئي وكان تأثير الليزر على الأنسجة المستخدم بهذه الطريقة هو تخثير النسيج حرارياً دون حصول أسوداد كاربوني ، وهذه الطريقة يمكن فقط مقارنتها بطريقة حقن جوف القناة بالصمغ الفايبريني والتي قد تنافس طريقة التخثير الضوئي لباطن القناة . تستنتج الدراسة انه بأستخدام التخثير الضوئي لباطن القناة يمكن شفاء ناسور المخرج واطئ المستوى دون الحاجة للاستئصال أو فتح سقف الناسور وانه لا توجد دلائل على حدوث ضرر لصمام المخرج باستخدام جرع الليزر التي تم اختيارها مسبقا .

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