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以兔子模式比較經睫膜睫狀體雷射和內視鏡雷治療青光眼的血流動力學

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關鍵詞 以兔子模式比較經鞏膜睫狀體電射和內視鏡雷治療青光眼的血流動力學

內容摘要 題目 以兔子模式比較經鞏膜睫狀體電射和內視鏡雷治療青光眼的血流動力學。目的 傳統上對於控制不易的青光眼，經鞏膜雷射是主要的治療方法，但它會造成許多併發症。內視鏡雷射的發明，提供我們另一種選擇，所以我們使用兔子模式來比較這兩種雷射對於睫狀體血流動力學的影響。方法 改裝內視鏡雷射機器，施行內視鏡螢光攝影於紐西蘭兔子眼內，以數位錄影方式記錄睫狀體血流，並以電腦計算螢光灌流。結果 急性期時兩種雷射後的睫狀體均呈現低度螢光狀態，兩術約一個月，經鞏膜雷射組仍表現混合不均勻螢光，電腦計算值也偏低，而內視鏡雷射組已部分恢復血流現高度螢光，計算值接近正常值。結論 內視鏡雷射較不會造成眼球萎縮，對於尚有視力的眼睛此方法值得推廣。

本文電子檔已上傳至出國報告資訊網

目的:

青光眼是一種因眼壓異常而導致視神經盤凹陷擴大和視野變壞的視神經病變。傳統上對於控制不易的青光眼，經鞏膜睫狀體雷射 (Transscleral cyclophotocoagulation) 是主要的治療方法。但是，它會造成許多併發症，例如眼壓過低，眼球萎縮等。最近內視鏡睫狀體雷射 (Endoscopic cyclophotocoagulation) 的發展，可以讓我們在目視下選擇治療的範圍，直接雷射治療睫狀體，避免燒灼周圍的組織，產生併發症。所以我們使用兔子模式，以內視鏡螢光攝影的方法，比較經鞏膜睫狀體雷射和內視鏡雷射治療青光眼，在急性期和慢性期對睫狀體的血流動力學的影響。

方法:

我們在內視鏡睫狀體雷射 (EndoOptiks, Littlesilver, New Jersy)的照相機及光源上，裝置合適的濾鏡後，施行內視鏡螢光攝影 (Endoscopic fluorescein angiography)。我們用數位式錄影機同步來記錄螢光攝影的結果。實驗對象為紐西蘭 (New Zealand Dutch-belt)兔子，共有三十五隻，其中五隻是對照組，其餘分為經鞏膜睫狀體雷射和內視鏡雷射兩組，每組十五隻，每組做完雷射治療後，分別有五隻在不同的時間點施行內視鏡螢光攝影。 時間為: 一馬上雷射後，一日後及一個月後。我們觀察數位式錄影機記錄的睫狀體血流完整性， 選擇注入螢光劑五至十秒，含有二到三個清楚睫狀體影像的相片， 並且以電腦計算出螢光 (computerized pixel intensity) 結果並統計分析。

結果

正常的睫狀體會在注入螢光劑的五秒內呈現螢光，並且持續保持這樣高度螢光（hyperfluorescent）的狀態。正常對照組的螢光電腦計算值為 68.73± 1.61。雷射治療後的睫狀體則呈現低度螢光（hypofluorescent）的狀態。一馬上雷射後，不論是經鞏膜睫狀體雷射組或內視鏡雷射組，睫狀體的血流都呈現嚴重減少或不存在的現象。螢光電腦計算值分別為 37.19± 16.19 和 33.42± 10.8。雷射一日後，經鞏膜睫狀體雷射組或內視鏡雷射組睫狀體的血流，與一馬上雷射後類似，螢光電腦計算值分別為 32.62± 8.75 和 33.21± 7.87。雷射一個月後，經鞏膜睫狀體雷射組表現混合高度和低度螢光，極度不規則表現，表示仍殘留未被雷射的組織及部分血流，螢光電腦計算值為 33.23± 7.97。內視鏡雷射組在早期呈現均勻螢光，與未經雷射處比較，在晚期呈現較少的滲漏，螢光電腦計算值為 56.02± 9.77，與對照組螢光電腦計算值差距不大。所以，我們發現內視鏡雷射組在雷射一個月後，已有部分恢復灌注的血流。

討論與建議

我們發現，在急性期，不論是經睫膜睫狀體雷射組或內視鏡雷射組，睫狀體的血流都呈現嚴重減少或不存在的現象。在慢性期，內視鏡雷射組在雷射一個月後，已有均勻恢復灌注的螢光，其電腦計算值接近對照組電腦計算值，差距不大，這點可以證明睫狀體的血流在內視鏡雷射組得到保存。反之，在雷射一個月後，經睫膜睫狀體雷射組表現許多低度螢光的區域，其電腦計算值持續保持在減少的狀況，同樣地，這也是臨床上內視鏡雷射組併發症較少的原因。

內視鏡雷射是一項最近研發的新技術，比傳統的經睫膜睫狀體雷射詠有更多的優點。目前，國內尚未引進這部機器，我們希望未來能夠引進國內，用在青光眼的病人身上，控制眼壓，治療青光眼。

Ciliary body vascular changes of cyclophotocoagulation in a rabbit model

Mei-Ju Chen

PURPOSE To determine the acute and chronic hemodynamic effects of endoscopic cyclophotocoagulation (ECP) versus transscleral cyclophotocoagulation (TCP) in a rabbit model

METHODS: The endoscopic laser (EndoOptiks, Little Silver,NJ) was fitted with appropriate color filters at the camera and light source ports to perform endoscopic fluorescein angiography (FA) FA was recorded in real time on digital video Five rabbits were used as controls for endoscopic FA of the ciliary body Fifteen rabbits underwent ECP in one eye and another fifteen rabbits had unilateral TCP Intraocular FA was performed immediately, one day and one month after surgery The eyes were evaluated in regards to their ciliary body vascular perfusion Five rabbits in each group had endoscopic ciliary body FA at each time point The vascular integrity of the ciliary processes was evaluated by the computerized pixel intensity calculation for three ciliary processes within a photographic frame

RESULTS Normal functional ciliary processes were fluorescent within 5 seconds of fluorescein injection and became hyperfluorescence with observation Ablated processes were hypofluorescent Immediately after laser, both TCP and ECP demonstrated severely reduced or nonexistent ciliary body blood flow The ciliary tissues of TCP eyes exhibited areas of central hypofluorescence with surrounding zones of hyperfluorescence which was indicative of less uniform treatment ECP showed areas of dense hypofluorescence, corresponding to the previous treatment site At one day, both TCP and ECP eyes showed similar findings as that of the immediate treatment At one month, TCP eyes showed markedly irregular pattern of mixed hypo- and hyperfluorescence This scattered fluorescence likely represented residual viable ciliary processes with partially perfused blood flow ECP eyes showed uniform early fluorescence with less leakage (hyperfluorescence) in the late phase, compared to the untreated processes Slightly less early fluorescence was observed when compared to the untreated processes Therefore, at least partially reperfused ciliary blood flow was noted in the ECP rabbits at 1 month post-treatment

CONCLUSIONS Uniform reperfusion of the ciliary body blood flow in the ECP-treated rabbits may indicate preservation of vascular perfusion to an important ocular tissue In contrast, TCP-treated eyes showed many areas of marked hypoperfusion at the 1-month time point This may account for the very low rates of

phthisis and hypotony observed with ECP in the clinical situation

INTRODUCTION

Transscleral cyclphotocoagulaton (TCP) is a cyclodestructive surgery reserved for more refractory cases of glaucoma and in eyes which have little or no visual potential TCP has been shown to be an effective surgery for treating end-stage and/or severe glaucoma[1-14] Even though TCP has been used effectively for managing refractory and severe glaucoma, it is a procedure that has a significant incidence of complications[1-18]

A new method to directly photocoagulate the ciliary body under endoscopic guidance--known as endoscopic cyclophotocoagulation (ECP)--has become increasingly important for the treatment of refractory glaucomas[19-20]. The laser unit for ECP (Endo Optiks, Little Silver, NJ) incorporates a diode laser that emits pulsed continuous-wave energy at 810 nm, a 175-watt xenon light source, a helium-neon laser aiming beam, and video camera imaging which can be recorded All four elements are transmitted via fiberoptics to a 20-gauge probe that is inserted intraocularly ECP has been shown to be an effective surgery for treating refractory glaucoma of various diagnoses[19-23] There were no instances of phthisis, endophthalmitis, retinal detachment, or sympathetic ophthalmia postoperatively

In ECP, there is selective ablation of aqueous-secreting ciliary body tissue, allowing sparing of adjacent tissues and, possibly, underlying vasculature This selectivity may ultimately be the reason for the relative low incidence of vision-threatening complications In order to more definitively demonstrate the advantages of ECP over TCP, we propose to set up a rabbit model to compare these two methods by investigating the acute and chronic hemodynamic changes associated with each procedure We have already made changes to the ECP machine to perform intraocular fluorescein angiography (FA) with these surgeries This is a pilot study using intraocular FA to evaluate the impact of cyclophotocoagulation on the perfusion of ciliary processes

METHODS

Thirty five New Zealand Dutch-belt rabbits were used in our study Five rabbits were used as controls for endoscopic FA of the ciliary body Fifteen rabbits underwent ECP in one eye and another fifteen rabbits had unilateral TCP Intraocular FA was performed immediately, one day and one month after surgery The eyes were evaluated in regards to their ciliary body vascular perfusion Five rabbits in each group had endoscopic ciliary body FA at each time point

Preoperatively, rabbits were sedated and anesthetized with ketamine 35-50 mg/Kg and xylazine 5-10 mg/Kg IM We also used topical Proparacaine 0 5% eye drops in the operated eye For TCP eyes, the Diode laser (IRIS Oculight SLx, Iris Medical Inc , Mountain View, CA) was performed The G probe was placed on the conjunctiva and sclera, centered 1 mm behind the limbus, and 9-10 spots were applied on the inferior-temporal quadrant Energy levels were titrated to avoid an audible "pop" which indicated overtreatment and explosion of the ciliary body tissue The energy settings ranged from 550 to 800 mW and the duration was 1 second Postoperatively, topical neomycin and polymyxin oilment and atropine (1 %) were given

ECP eyes were prepared with antibacterial solution and draped A limbal incision paracentesis was made with a superblade on the superior-nasal quadrant The viscoelastic (Healon-5) was injected beneath the iris to fill and artificially expanded the ciliary sulcus The endoscpic laser (EndoOptiks, Little Silver,NJ) was used After orientation of the probe image outside of the eye, the 20-gauge probe was inserted through the incision and into the posterior sulcus At this time, the ciliary processes were viewed on the monitor and treatment could begin The laser was set on continuous wave and energy settings are 0 15 W Approximately a 90-degree span of ciliary processes were photocoagulated Laser energy was applied to each process until shrinkage and whitening occurred After the inferior-temporal cilary processes were treated, residual viscoelastic is removed with a Simcoe irrigation and aspiration device and the wound was closed with a single interrupted 10-0 nylon suture Sub-Tenon's injection of 1cc of triamcinolone (40 mg/5 cc) is given immediately at the end of ECP Also, topical neomycin/polymyxin ointment and atropine (1 %) were given

To perform endoscopic FA, the endoscopic laser was fitted with appropriate color filters at the camera and light source ports 1 ml of 10% sodium fluorescein was injected into rabbit's long ear vein FA was recorded in real time on digital video 10-15 seconds after fluorescein was first seen on the screen, we captured a photographic frame which included three ciliary processes The vascular integrity of the ciliary processes was evaluated by computerized pixel intensity calculation To calculate the pixel intensity, the Scion-image software was used to trace around each ciliary body The program can determine the average pixel intensity within each tracing

RESULTS

Normal functional ciliary processes were fluorescent within 5 seconds of fluorescein injection and became hyperfluorescence with observation (Fig 1) Ablated processes were hypofluorescent Immediately after laser, both TCP and ECP demonstrated severely reduced or nonexistent ciliary body blood flow (Fig 2 and 3) The ciliary tissues of TCP eyes exhibited areas of central hypofluorescence with surrounding zones of hyperfluorescence which was indicative of less uniform treatment ECP showed areas of dense hypofluorescence, corresponding to the previous treatment site At one day and one week, both TCP and ECP eyes showed similar findings as that of the immediate treatment (Fig 4 and 5) At one month, TCP eyes showed markedly irregular pattern of mixed hypo- and hyperfluorescence (Fig 6) This scattered fluorescence likely represented residual viable ciliary processes with partially perfused blood flow ECP eyes (Fig 7) showed uniform early fluorescence with less leakage (hyperfluorescence) in the late phase, compared to the untreated processes Slightly less early fluorescence was observed when compared to the untreated processes Therefore, at least partially reperfused ciliary blood flow was noted in the ECP rabbits at 1 month post-treatment

The mean computerized pixel intensity of fluorescein in each group was shown in Table Both TCP and ECP eyes demonstrated remarkably decreased fluorescence immediately and one day after laser At one week, both TCP and ECP eyes showed similar findings compared with immediate and 1-day data. At one month, TCP eyes still remained reduced fluorescein intensity while ECP eyes revealed as almost the same fluorescence intensity as normal controls

DISCUSSION

In our study, uniform reperfusion of the ciliary body blood flow in the ECP-treated rabbits may indicate preservation of vascular perfusion to an important ocular tissue In contrast, TCP-treated eyes showed many areas of marked hypoperfusion at the 1-month time point For quantifying the fluorescein perfusion, there is no accepted standard up to now We try to set up a method to capture a photo image at a fixed time point and to calculate the pixel density These data also showed regained fluorescein intensity indicative of the ciliary body reperfusion in the ECP-treated rabbits

Endoscopic, intraocular fluorescein angiography has not been reported in the literature Our study has established the physiological and histological basis for the absence of phthisis and the low incidence of vision loss with ECP, compared to TCP This information may help to convince other ophthalmologists to consider ECP for refractory glaucoma in cases in which vision is still relatively intact We also developed a new in vivo technique for assessing ciliary body blood flow This

technique will help in the future study of new technologies for treating ciliary processes In addition, it may help in the development of treatments which will spare damage to the vasculature of the ciliary body

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Table The mean computerized pixel intensity of fluorescein

	Before laser	Immediate after	One day	One week	One month
Control	68 73±1 61				
TCP		37 19±16 19	32 62±8 75	33 01±9 9	33 23±7 97
ECP		33 42±10 8	33 21±7 87	28 99±6 22	56 02±9 77