·综　　述·

经巩膜睫状体光凝作为青光眼首选手术方式的探讨及展望

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【摘要】 睫状体光凝是难治性青光眼的主要治疗手段之一,其降眼压速度快、效果佳,但由于存在眼球萎缩和视力下降的风险,使其临床应用受到限制。经巩膜睫状体光凝的术后效果及并发症的发生主要与激光能量、点数、范围等操作参数以及患者眼部色素水平有关。其降眼压作用不依赖于房角开放状况,对操作技术要求相对较低。随着技术的进步和光凝参数的优化,睫状体光凝的安全性和有效性较前大大提高。同时由于其非侵入的特性,避免了许多青光眼滤过手术相关的严重并发症。结合地区经济发展水平、医疗资源配置情况、患者意愿和随访依从性等因素,近年来有研究者尝试将经巩膜睫状体光凝用于视力尚好的原发性开角型青光眼患者和药物控制不佳的慢性闭角型青光眼,并作为新生血管性青光眼的首选手术治疗方案,取得了较好效果,为青光眼的治疗提供了新的思路。本文对经巩膜睫状体光凝的安全性、有效性及其影响因素进行了综述,同时对其作为青光眼患者首选手术治疗方案的可能性和可行性作以分析、探讨和展望。

【关键词】 经巩膜睫状体光凝;青光眼;安全性;有效性

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Diode laser transscleral cyclophotocoagulation as a primary surgical treatment for glaucoma-questions and future

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[**Abstract**] Cyclophotocoagulation is one of the efficacious procedures for the treatment of refractory glaucoma. However, its clinical utilization is limited due to severe post-operative complications including phthisis and visual loss. Transscleral cyclophotocoagulation (TCP) is technically simple and less affected by the opening status of the anterior chamber angle. Its effectiveness and complications are mainly related to the energy, spots and scale of the surgery, as well as the ocular pigmentation of the patients. With the advance of technology, both the effectiveness and safety of this procedure gain significant improvement. Meanwhile, it is free from the filtration surgery-related complications due to its noninvasive characteristics. Taken the local economic level, medical resources allocation, as well as the patients´ preference and follow-up into account, utilization of TCP on primary open angle glaucoma (POAG) patients with good vision, or as primary surgical treatment for medically uncontrolled chronic angle closure glaucoma (CACG) and neovascular glaucoma (NVG) were recently tried and showed good preliminary results. It provides new insight in glaucoma therapy, although further evidence from prospective, random control trials are still needed. In present review, both the safety and efficiency, as well as related influent factors of TCP were summarized. The possibility and feasibility of this procedure as a primary surgical treatment for glaucoma were discussed.

[**Key words**] Transscleral cyclophotocoagulation; Glaucoma; Safety; Effectiveness

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睫状体破坏性手术是通过破坏部分睫状突，减少房水生成，降低眼压的方法。1933 年 Weve 提出睫状体破坏性手术的概念，这一术式经历了睫状体透热术、睫状体冷凝术、超声和微波睫状体破坏术、放射性睫状体破坏术、睫状体电解术等术式改良[1-11]，手术的成功证实以睫状体为靶点的降眼压治疗的可行性，但由于这些手术的成功率较低且存在眼球萎缩、视力丧失、巩膜穿孔等并发症而逐渐被放弃。睫状体光凝术的出现为睫状体破坏性手术开启了新篇章。1969 年 Vucicevic 等[12]在兔眼中尝试利用红宝石激光进行睫状体光凝。1994 年周炜等[13]在兔眼中应用 Nd:YAG 激光进行接触式经巩膜睫状体光凝的实验研究，证明聚焦头位于角巩像后 1.0 mm，5 J 的能量可使睫状体组织明显破坏而不损伤巩膜，可以替代昂贵的蓝宝石激光。此后其他类型的激光睫状体光凝术陆续被报道。

睫状体光凝的安全性和有效性较之前的睫状体破坏性手术明显提高，而破坏性则有所减小。Nd:YAG 激光，尤其是二极管激光的出现真正使得经巩膜睫状体光凝术在临床上得以广泛应用。二极管激光靶向性地破坏睫状体色素上皮和血管，引起睫状体的缺血和凝固性坏死，减少房水生成，是治疗难治性青光眼的常用方法[14]，在缓解新生血管性青光眼（neovascular glaucoma，NVG）患者的眼部疼痛和控制眼压方面具有较好的效果，还可用于引流阀植入术后眼压失控硅油取出术后眼压仍不能降低等的难治性青光眼[15-17]。近年来，内窥镜辅助的睫状体光凝术（endoscopic photocoagulation，ECP）也被应用于临床[18]。ECP 能够在直视下进行睫状突的光凝，使用能量更小，仅使睫状突变白、收缩而不产生组织爆破，减少了疼痛和术后炎症反应，被越来越多的医师开始尝试与超声乳化白内障摘出术联合作为青光眼的首选手术治疗[19-21]，其缺点是由非侵入性的眼外操作变成了需要制作切口的侵入性眼内操作，增加了眼内手术相关并发症[22-23]。由于存在晶状体损伤等风险，ECP 在有晶状体眼中的应用受到了一定的限制。

1　经巩膜睫状体光凝的有效性及其影响因素

对于睫状体光凝治疗成功的定义存在很大差异，不同的研究分别采用眼压<18 mmHg（1 mmHg = 0.133 kPa）、<21 mmHg 和<22 mmHg 及眼压降低幅度为 20% ~30% 等作为成功标准[24-28]。以眼压控制在 21 mmHg 及以下作为成功标准时，经巩膜睫状体光凝的成功率为 36.7% ~94.4%[25,29-30]。较高的激光总能量可以获得相对更低的术后眼压和更少的二次治疗比例，且不增加严重并发症的发生率[30-31]。激光点数对术后眼压也存在影响。叶兴桥等[32]观察了不同点数的二极管激光经巩膜睫状体光凝对兔眼压的影响，发现光凝 12 点组兔的眼压降低幅度显著低于光凝 36 点组，提示光凝点数与术后眼压降低程度成正比。Tzamalis 等[33]发现应用固定的单点脉冲能量，术后眼压降低幅度与光凝点数呈显著正相关。Chang 等[34]对比了激光能量 2.5 W、脉冲时间 2.0 s、平均点数 27 与激光能量 2 W、脉冲时间 1.5 s、平均点数 55 点 2 种激光参数条件下睫状体光凝的效果，结果显示术后 1 个月，高能量低点数组患者的眼压降低幅度和前房炎症反应的发生率明显高于低能量多点数组，而术后 6 个月，2 个组眼压降低幅度无明显差异，但高能量低点数组所需的降眼压药物种类明显少于低能量多点数组。因此，为了获得更好的降眼压效果，应在可行范围内选择较高的激光能量，而非增加激光点数。与以上研究不同，Roider 等[35]认为激光能量和点数与降眼压效果无明显相关关系，术后眼压主要与术中爆破声次数呈负相关。王光洁等[36]分别采用爆破声能量及小于爆破声能量对有色素兔和无色素兔进行经巩膜睫状体光凝，发现有色素兔术后的平均眼压与术中出现爆破声的次数呈负相关，睫状体的组织病理学改变随激光能量的增加而加重，无色素兔对于不同激光能量的反应皆小于色素兔，提示睫状体光凝效果受到爆破声和眼部色素水平的影响。

不同患者的睫状体色素水平以及巩膜、筋膜组织厚度等存在差异，即使应用相同的激光参数也可能因为眼部组织对激光能量的传导、反射和吸收的不同而引起差别巨大的术后反应。近年来有研究者尝试将高频超声和 OCT 用于睫状体光凝术中的实时成像，以直观判断光凝效果，指导术中参数的调整，取得初步成功[37-38]。Aquino 等[39]将微脉冲激光应用于经巩膜睫状体光凝，与传统的连续波激光持续向睫状突传递高强度激光能量不同，微脉冲激光采用连续描绘的方式将一系列重复的短脉冲激光能量作用于睫状体平坦部，其降眼压作用明显优于传统睫状体光凝，且作用更持久、效果更可控、并发症更少。

患者年龄、术前眼压、青光眼类型、眼部手术史等也与睫状体光凝的成功率相关，高龄患者的光凝成功率高于年轻患者[15,40]。原发性开角型青光眼（primary open angle glaucoma，POAG）、NVG 以及继发于炎症的青光眼对睫状体光凝的反应性明显高于先天性或青少年型青光眼、外伤性青光眼、剥脱性青光眼和无晶状体眼的青光眼[25,40]。Rebolleda 等[41]研究发现，光凝术前仅接受过药物治疗的患者成功率明显高于曾接受过睫状体光凝或滤过性手术的患者。Grueb 等[25]和 Kramp 等[27]的研究显示，术前未接受过青光眼手术、首次接受睫状体光凝的患者其成功率显著高于曾接受过眼部手术者。睫状体光凝作为青光眼的首选手术治疗方案可能有助于提高成功率。

2　经巩膜睫状体光凝的并发症及其影响因素

经巩膜睫状体光凝的术后并发症包括疼痛、炎症反应、交感性眼炎、出血、低眼压、眼球萎缩、视力丧失、色素播散、无张力性瞳孔、晶状体半脱位、坏死性巩膜炎等[42-46]，很难严格界定某些并发症是源于光凝操作本身还是与患者自身眼部的异常或疾病自然病程有关。随着技术的改进，这些并发症的发生率已大大降低。研究发现，光凝术后最严重的并发症是眼球萎缩，其发生率为 0% ~9.9%，与总的激光能量有关[42]。Aujla 等[47]研究发现，发生低眼压或眼球萎缩的患眼接受的总激光能量明显高于未发生这些并发症眼。激光总能量小于 80 J 时几乎不发生术后低眼压和眼球萎缩，总能量大于 80 J 时，这 2 种并发症的发生率明显增加。较高的术前眼压和 NVG 也是光凝术后低眼压和眼球萎缩的重要危险因素，原发性青光眼患者的发生率较低[48-49]。

临床应用限制睫状体光凝的另一个重要原因是术后视力

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下降的风险，但近年来睫状体光凝在较好视力眼中的应用为其安全性提供了支持。Ishida[42]分析了 2000 年后有关睫状体光凝术后并发症的 19 个研究，发现术后视力下降大于 Snellen 视力表 2 行及以上者占 0% ~ 55.2%，平均为 22.5%。Ansari 等[50]发现光凝术前视力大于 6/36 的患眼随访 12 个月视力无明显下降。研究显示，光凝（能量为 2 W，点数为 14，范围为 270°）术前视力≥20/60 的患眼后 12 个月视力下降 2 行及以上者占 18%，低于青光眼引流阀植入术的 27% 和小梁切除术的 24%[51-52]。术后 5 年睫状体光凝的总体成功率为 79.6%，视力下降的发生率为 30.6%，略低于小梁切除术的 40.0%。Ghosh 等[53]分析了二极管睫状体光凝在视力 6/18 及以上的青光眼患者中的效果，术后 24 个月的成功率为 84.8%，39.1% 患眼视力无变化，76.1% 患眼视力提高，19.4% 患眼的术后视力<6/60。虽然经巩膜睫状体光凝存在视力下降的可能，但其风险与传统抗青光眼手术相比并不增加。选择适宜的激光参数、保留一定比例的睫状突不受光凝、做好详细的手术记录以作为重复治疗时的参考对于提高睫状体光凝的安全性和有效性至关重要。

3　青光眼手术治疗中面临的难题

保守治疗眼压控制不佳的进展型青光眼患者通常需行抗青光眼手术治疗，滤过性手术是目前的主要术式。小梁切除术的降眼压幅度可达 30% 以上，POAG 的 3 年成功率为 54%，正常眼压性青光眼患者术后 1、2、3 和 4 年的成功率分别为 91.1%、74.1%、64.8% 和 62.1%[54-55]。术后浅前房、角膜内皮失代偿、恶性青光眼、滤过泡感染、滤过泡瘢痕化、低眼压性视网膜病变等手术相关并发症是滤过手术失败和视功能损伤的重要原因[55-57]。Express 引流钉植入术等一定程度上减少了传统滤过手术的术中、术后并发症[58-63]。引流阀植入术是难治性青光眼的主要术式之一，具有较好的降眼压效果，但存在术后角膜内皮失代偿、引流管暴露、滤过通道瘢痕化、低眼压和眼球萎缩、眼内炎等严重并发症。Bloom 等[64]比较了引流阀植入术与二极管睫状体光凝治疗难治性青光眼的术后效果，发现前者的眼压控制率为 78%，稍高于后者的 71%，术后视力下降、视网膜脱离、白内障进展、脉络膜驱逐性出血、眼内炎、低眼压和眼球萎缩的发生率分别为 16%、9%、7%、4%、2% 和 4%，明显高于睫状体光凝组的 9%、0%、0%、0%、0% 和 2%。在首次引流阀植入失败的青光眼患者行二次引流阀植入或睫状体光凝，前者术后视力下降的发生率和远期手术失败率分别为 36% 和 60%，明显高于后者的 17% 和 34%[16]。这些研究提示滤过性手术虽然具有较好的降眼压效果，但手术相关并发症仍是函待解决的问题。

除手术本身的因素外，经济不发达地区的医疗资源有限、配置不均衡、患者经济条件差及随访困难等原因使滤过性手术的实施受到很大限制。循证医学和循值医学研究发现，患者和医师对疾病严重程度的感受以及对治疗方法的选择方面存在很大差异[65-66]，以患者为中心的医疗模式将患者的主观意愿引入临床治疗策略的制定[66-67]。对于青光眼治疗方法的选择，除了疾病本身，还要考虑患者主观意愿、地区经济水平、公共健康资源和医疗服务配置等因素。

4　经巩膜睫状体光凝作为青光眼首选手术治疗的应用

由于临床实践中尚缺乏规范的睫状体光凝参数的计算方法，且术后仍然存在视力下降和眼球萎缩的风险，大多数医师主张将睫状体光凝应用于晚期或难治性青光眼，不宜作为青光眼的首选术式[47,68]。随着技术的进步，睫状体光凝的成功率和安全性已大大提高。大量的研究数据显示，经巩膜激光睫状体光凝术后严重并发症的发生率并不大于滤过性手术，同时由于其非侵入性的优点，有效避免了滤过手术相关的严重术后并发症，其降眼压作用不依赖于房角开放状况，对操作技术要求较低，不损伤结膜，也不影响未来的抗青光眼手术。睫状体光凝设备简易便携且价格低廉，更适于经济不发达地区。将睫状体光凝作为药物难以控制的青光眼患者的首选手术方式在理论上具备可行性。

2001 年，Egbert 等[28]对小梁切除术和经巩膜睫状体光凝（能量 1.5 W、持续 1.5 s 组和能量 1.25 W、持续 2.5 s 组，全周 360°均匀分布 20 点）作为加纳地区 POAG 首选手术方案的降眼压效果进行了对比，以眼压≤22 mmHg 作为成功标准，睫状体光凝的成功率为 48%，明显低于小梁切除术的 73% ~ 93%，但除了无张力瞳孔以及略高的视力下降比例外，睫状体光凝的术后并发症明显少于小梁切除术，且程度较轻，2 个激光剂量组间的治疗效果无明显差异。Schulze-Schwering 等[69]对光凝参数进行优化，采用低能量（900 mW）、低点数（上方和下方象限各 6 个点）的设计，观察其作为马拉维地区 POAG 患者首选手术治疗方案的效果，结果显示术后 3 个月眼压下降>25% 的患者占 50%，除了无张力瞳孔和一过性的轻度虹膜炎外，无其他严重并发症，患者对睫状体光凝的接受度良好。

Lai 等[26]对药物治疗眼压控制不佳的慢性闭角型青光眼患者进行下方 270°的经巩膜睫状体光凝，激光能量为（2 079.0±125.1）mW，点数为 14 ~ 25 点，平均 16.3 点，以联合或不联合局部降眼压药物条件下眼压<21 mmHg 作为成功标准，结果显示术后 12 个月睫状体光凝的总体成功率为 85.7%，患者眼压由术前的（36.9±11.7）mmHg 降至（18.9±6.5）mmHg，应用降眼压药物的种类由 1.9±0.7 降至 0.4±0.8，随访 18 个月时成功率为 92.3%，平均眼压为（18.7±12.2）mmHg，用药数量为 2.1±0.9；15.4% 的患眼术后视力不同程度提高，46.2% 的患眼视力无明显改变，38.5% 的患眼视力较术前下降，所有患者未发生严重并发症[29]。Yildirim 等[70]对比了经巩膜睫状体光凝及青光眼引流阀植入术作为 NVG 首选手术方案的效果，以眼压控制于 5 ~ 21 mmHg作为成功标准，随访 24 个月，2 种方法的成功率相当，视力分别下降 24% 和 27%，引流阀植入组患者的术后并发症明显多于光凝组。Fong 等[71]比较了单纯睫状体光凝以及睫状体光凝联合贝伐单抗玻璃体腔注射治疗 NVG 的疗效，结果显示单独光凝组及联合治疗组的眼压降低幅度分别为 33.5 mmHg 和 33.7 mmHg，前者术后低眼压的发生率为 27%，略高于联合治疗组的 10%。可见，睫状体光凝的降眼压效果与引流阀植入术以及光凝联合抗 VEGF 药物治疗的效果相当、并

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发症较少、操作简便且耗时少，可作为 NVG 的首选。

综上所述，经巩膜睫状体光凝的安全性和有效性已大大提高，但临床实践中仍缺乏确定最佳治疗参数的方法。经巩膜睫状体光凝的非侵入性以及在视力较好眼中的成功应用为其作为青光眼首选手术治疗方案提供了证据，可为青光眼治疗带来新的思路，但尚缺乏大样本的前瞻性、随机对照临床试验证据。经巩膜睫状体光凝的治疗指征、激光参数以及与青光眼滤过性手术远期效果的比较尚待于进一步研究。

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