

# 手术干预开角型青光眼临床研究证据图谱

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## 摘要

目的: 通过对手术干预开角型青光眼的临床研究文献进行整理和分析, 探索并呈现手术干预开角型青光眼的证据质量。方法: 检索中国知网(CNKI)、万方(Wanfang)、维普(VIP)、PubMed、Web of Science、Embase数据库中手术干预开角型青光眼的临床研究文献, 对纳入的文献用Excel整理, 进行手术干预开角型青光眼的临床证据图谱取表, 对样本量、干预措施、疗效评价指标、文献质量评价等内容进行统计分析, 并制作气泡图、流程图、偏倚风险图等, 将该领域相关证据进行可视化处理并分析。结果: 最终纳入47篇临床研究, 干预措施中内路小梁切开术(GT)占比较大, Ex-PRESS引流钉植入术占比较小。文献质量评价方面, 高风险偏倚占大部分。证据图谱显示, 手术干预开角型青光眼有一定疗效, 纳入文献中共有66项研究, 其结局中20项为有效, 27项为可能有效, 16项为不确定, 3项为无差别效应。结论: 手术在干预开角型青光眼方面显示出一定疗效, 其临床应用已被广泛报道, 然而, 纳入的临床研究的偏倚风险较高, 限制了可靠性和证据的强度。未来需要高质量的研究来提高证据质量。

## 关键词

手术, 开角型青光眼, 证据图谱

# Evidence Map of Clinical Research on Surgical Interventions for Open-Angle Glaucoma

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## Abstract

**Objective:** To explore and present the quality of evidence for surgical intervention in open-angle glaucoma through the collation and analysis of clinical research literature on this topic. **Methods:** Clinical research literature on surgical intervention for open-angle glaucoma was retrieved from databases including CNKI, Wanfang, VIP, PubMed, Web of Science, and Embase. The included literature was organized using Excel, and a clinical evidence map was created for surgical intervention in open-angle glaucoma. Statistical analysis was conducted on sample size, intervention measures, outcome evaluation indicators, and literature quality assessment. Bubble charts, flowcharts, and bias risk diagrams were produced to visualize and analyze the relevant evidence in this field. **Results:** A total of 47 clinical studies were included. Among the intervention measures, trabeculotomy (GT) accounted for a large proportion, while Ex-PRESS shunt implantation accounted for a small proportion. In terms of literature quality assessment, high-risk bias was predominant. The evidence map indicated that surgical intervention for open-angle glaucoma had certain therapeutic effects. Among the 66 studies included in the literature, 20 were effective, 27 were possibly effective, 16 were uncertain, and 3 showed no difference in effect. **Conclusion:** Surgery has shown certain therapeutic effects in the intervention of open-angle glaucoma and has been widely reported in clinical applications. However, the included clinical studies had a high risk of bias, which limited the reliability and strength of the evidence. Future high-quality research is needed to improve the quality of evidence.

## Keywords

Surgery, Open-Angle Glaucoma, Evidence Map

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## 1. 引言

青光眼是一组伴有特征性视野缺损与视盘和视网膜神经纤维层损害的视神经病变的疾病, 是全球首位不可逆性致盲性疾病[1]。根据房角是否开放, 青光眼分为开角型青光眼(open angle-glaucoma, OAG)和闭角型青光眼(close angle glaucoma, CAG)。病理性眼压升高是青光眼病情进展的主要危险因素[2]。青光眼的治疗主要是通过药物、激光和手术来降低眼压。经过不断的探索及发展, 小梁切除术(trabeculectomy, TRAB)逐渐发展成为现在的复合式小梁切除术。TRAB 是目前抗青光眼手术的金标准, 也是我国目前最常见的抗青光眼手术类型[3]。传统的滤过性手术虽然具有良好的降压效果, 但其存在的术中、术后并发症仍不容忽视, 如前房出血、浅前房、脉络膜脱离、低眼压性黄斑病变、薄壁滤过泡、滤过泡感染、滤过泡渗漏、爆发性脉络膜上腔出血、恶性青光眼等[4]。近年来, 具有微创、有效降低眼压、安全性高、生物相容性高等优点的微创青光眼手术(minimally invasive glaucoma surgeries, MIGS)逐渐兴起[5]。尽管手术治疗对 OAG 的治疗效果显著, 但繁多的手术方式缺乏系统的梳理与总结; 此外, 通过检索、整理该领域文献发现, 该领域文献繁多、研究类型多样, 至今少有文献对该领域的临床证据进行总结。

证据图谱是对特定研究领域的已知数据进行全面解读与科学评估, 然后用直观的方式揭示该领域的当前情况、存在的难题、未来的趋势。这种新型证据综合研究方法, 与获得普遍认可的系统评价、系统评价再评价相比较, 突破了仅针对具体问题证据的局限, 着眼于对更为广泛的某一研究领域中的证据进

行评价和综合, 并以更为直观的方式呈现, 更加快速、便捷地对相关研究领域的证据进行科学的整合、分析、凝练和呈现[6]。手术治疗开角型青光眼一直是青光眼研究的热点, 本研究通过证据图谱对手术治疗开角型青光眼的临床研究文献进行综述, 旨在通过展示现有的有效性和安全性的证据为 OAG 手术治疗的选择和临床研究提供参考。

## 2. 资料与方法

### 2.1. 文献检索

计算机检索中国知网(CNKI)、万方(Wanfang)、维普(VIP)、PubMed、Web of Science、Embase 等数据库, 检索时间为 2015 年至 2025 年 11 月 29 日。中文检索词: 开角型青光眼、手术、微创青光眼手术、小梁切除术、小梁切开术、Schlemm's 管成形术等。英文检索词: open-angle glaucoma、surgery、micro-invasive-glaucoma surgery、trabeculectomy、trabeculotomy、canaloplasty 等。

### 2.2. 纳入标准

符合开角型青光眼的诊断, 以手术为主要治疗方法(见检索词); 文献类型是手术治疗 OAG 的随机对照试验, 随机方式不限, 盲法不限; 干预措施为治疗 OAG 的各类手术方式, 手术成功率明确, 手术前后的眼压、抗青光眼药物数量变化明确, 术后并发症种类及数量明确。

### 2.3. 排除标准

与研究主题不相关的文献; 重复发表的文献; 质量过低的文献; 数据不充分的文献, 如会议摘要、实施方案等。

### 2.4. 文献资料提取

本研究采用 Microsoft Excel 构建数据提取表, 在符合入选标准的临床研究文献中提取需要的信息, 按第一作者、发表时间、干预方法、样本量、结局指标等进行分类提取信息。

### 2.5. 数据分析

#### 2.5.1. 研究结论分类

将纳入研究的结果和结论分为 5 种类型[6], 见表 1。

**Table 1.** Standard table of result conclusion types

**表 1.** 结果结论类型标准表

类型	解释
有益	文献结果和结论中明确表明了治疗效果和益处, 且质量不影响结论
可能有益	结论中提到治疗效果但未明确受益方面, 或差异无统计学意义, 仅报告了该治疗手段的潜在好处
有害	文献结果和结论中报告了明确的不良反应
无差别效应	对照组与研究组的治疗措施之间比较得出的结果和结论无明显差异
不确定	研究结果无法使作者得出明确或可能的治疗效果及影响

#### 2.5.2. 证据图谱

在 Excel 软件绘制气泡图以展示研究特性。文献以气泡形式呈现, 不同颜色的气泡则是不同的文献

质量, 气泡大小代表纳入原始研究的样本量。不同的干预措施在 X 轴呈现, 研究结论分为有益、可能有益、有害、无差别效应、不确定等在 Y 轴呈现。

### 3. 结果

#### 3.1. 文献筛查

初步检索到文献 3485 篇, 删除重复文献 2272 篇, 先进行阅读文题与摘要初筛, 再进行阅读正文复筛, 最终得到 47 篇文献, 详细的文献筛选流程如图 1 所示。

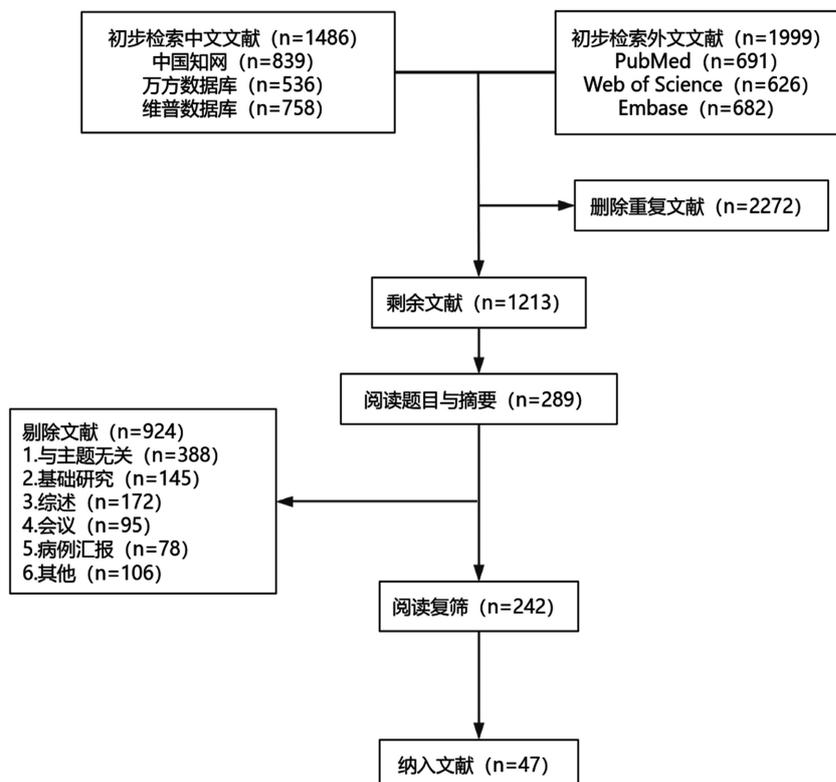


Figure 1. Literature screening process  
图 1. 文献筛选流程

#### 3.2. 文献基本特征

共纳入 47 篇文献[7]-[53]。截至 2025 年 11 月 29 日检索结束日期, 大部分文章发表于 2020 年(10 篇, 21.28%, 10/47)。大部分文献发表于 2020~2024 年, 占 36 篇(76.59%, 36/47), 随时间呈现明显的上升趋势。每项研究纳入的样本量差异很大, 从 17 名到 428 名不等。采用了各种手术干预方法, 包括穿透性 schlemm 管成形术(PCP)、内路粘小管成形术(*ab interno* canaloplasty, Abic)、传统外路粘小管成形术(*canaloplasty*, CP)、外路小梁网切除术、内路小梁网切除术、内路小梁网切开术(*goniotomy*, GT, 360/240/120°)、准分子激光小梁网切开术(*excimer laser trabeculotomy*, ELT)、iStent 植入术、Ex-PRESS 引流钉植入术等。干预措施的分布包括: PCP(4 项研究)、CP(1 项研究)、Abic(5 项研究)、外路小梁网切除术(9 项研究)、内路小梁网切除术联合 Abic(2 项研究)、GT(27 项研究)、XEN 引流管植入术(6 项研究)、内路小梁网切除术(3 项研究)、内路小梁网切除术联合内窥镜下睫状体光凝术(ECP)(1 项研究)、外路小梁网切开术(1 项研究)、iStent 植入术(2 项研究)、ELT(2 项研究)、GT 联合 Abic(2 项研究) Ex-PRESS 引流钉植入术(1

项研究)。

### 3.3. 随机对照试验的偏倚风险

纳入随机对照试验的偏倚风险评估结果如图 2 所示, 2 项研究使用随机数字表法进行分组, 其余 45 项研究均未使用随机分组方法, 存在高偏倚风险。干预分配盲法中, 47 项研究均描述分配可见, 并没有描述是否对研究产生影响, 存在高偏倚风险, 47 项研究均未分配隐藏, 均未对结局测量者施盲, 但对研究不产生影响。在结果数据完整性中, 47 项研究结果数据均完整。选择性报告中, 37 项研究报告了指定的研究结果, 10 项研究没有相关信息。综上, 47 项研究均被判断为高偏倚风险。

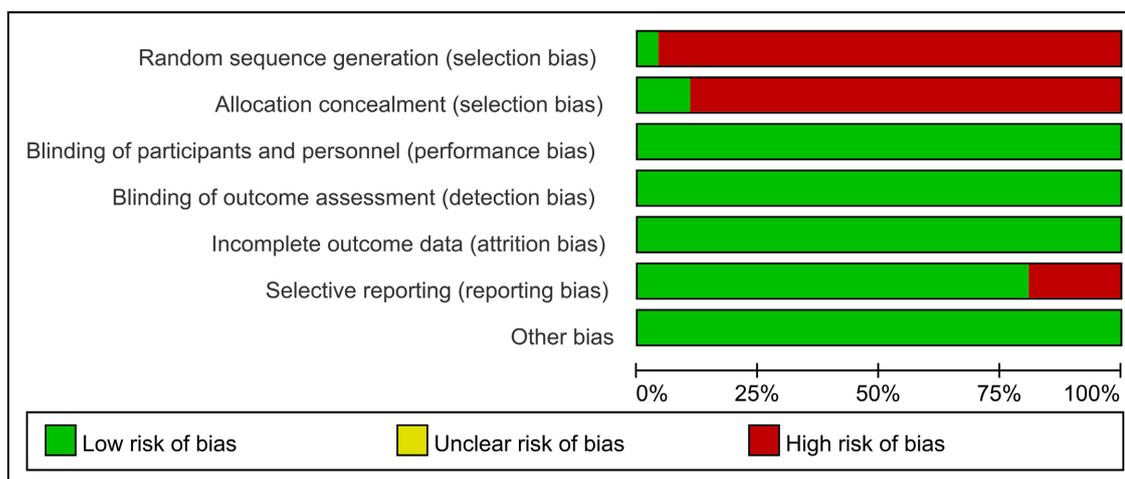


Figure 2. Assessment of bias risk of included studies

图 2. 纳入研究的偏倚风险评估

### 3.4. 证据图谱

气泡图(图 3)提供了对手术干预开角型青光眼的临床研究的概述。纳入的 47 篇临床研究的 66 项干预措施中 20 项为有效, 27 项为可能有效, 16 项为不确定, 3 项为无差别效应。手术治疗结局中, 共包括 7 种疗效评估指标: 指标 1 为末次随访眼压  $6 \text{ mmHg} \leq \text{IOP} \leq 21 \text{ mmHg}$  且 IOP 降低  $\geq 20\%$ , 指标 2 为末次随访眼压  $6 \text{ mmHg} \leq \text{IOP} \leq 18 \text{ mmHg}$  且 IOP 降低  $\geq 20\%$ , 指标 3 为末次随访眼压  $6 \text{ mmHg} \leq \text{IOP} \leq 15 \text{ mmHg}$  且 IOP 降低  $\geq 20\%$ , 指标 4 为末次随访眼压平均 IOP 较基线降低百分比, 指标 5 为末次随访使用抗青光眼药物较基线减少百分比, 指标 6 为并发症(前房积血)发生率, 指标 7 为再手术率。

指标 1 中, 9 项研究对开角型青光眼手术治疗结局显示有益; 15 项研究显示可能有益, 6 项研究显示不确定, 1 项研究显示无差别效应。指标 2 中, 9 项研究对开角型青光眼手术治疗结局显示有益; 12 项研究显示可能有益, 5 项研究显示不确定, 2 项研究显示无差别效应。指标 3 中, 6 项研究对开角型青光眼手术治疗结局显示有益; 6 项研究显示可能有益, 5 项研究显示不确定, 2 项研究显示无差别效应。指标 4 中, 1 项研究对开角型青光眼手术治疗结局显示有益; 18 项研究显示可能有益, 20 项研究显示不确定, 6 项研究显示无差别效应。指标 5 中, 14 项研究对开角型青光眼手术治疗结局显示有益; 15 项研究显示可能有益, 14 项研究显示不确定, 2 项研究显示无差别效应。指标 6 中, 19 项研究对开角型青光眼手术治疗结局显示有益; 21 项研究显示可能有益, 3 项研究显示不确定, 2 项研究显示无差别效应。指标 7 中, 26 项研究对开角型青光眼手术治疗结局显示有益; 10 项研究显示可能有益, 1 项研究显示不确定, 3 项研究显示无差别效应。所有指标中均无研究显示有害。偏倚风险评估中, 47 篇研究均为高偏倚风险。

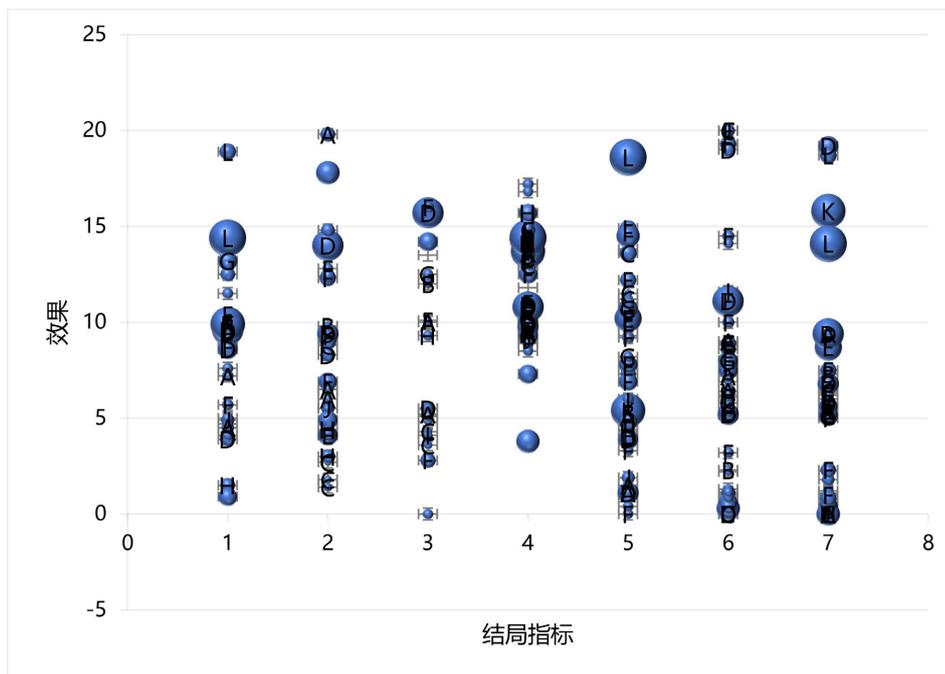


Figure 3. Bubble chart  
图 3. 气泡图

#### 4. 讨论

在本文中, 对 47 篇关于手术干预开角型青光眼的临床研究进行了批判性的回顾和评估, 并进行了证据图谱分析。手术干预开角型青光眼的研究起步较早, 近年来发展迅速, 各种微创手术方式越来越多。使用 Review Manager 工具进行偏倚风险评估, 发现纳入的所有研究均具有高偏倚风险。纳入文献质量偏倚风险高的主要原因是未使用随机分组方法, 此外也有 10 项研究未报告指定的研究结果, 这与临床研究的特殊性相关。本部分通过详细分析手术干预开角型青光眼的临床研究, 能够准确地描述该领域的研究内容分布、趋势概况, 揭示未来研究的潜在方向, 深入探讨最优手术方式。

本研究整理分析了 2015 年至 2025 年期间发表的 47 项临床研究的资料, 这些资料集中反映了研究者对微创青光眼手术的研究日益增长, 手术方式更多样、研究更深入。大部分文献发表于 2020~2024 年, 微创青光眼手术方式占比大幅提高, 其中内路小梁切开术占比最大, 近年来关于 XEN 植入术、iStent 植入术、Ex-PRESS 引流钉植入术的研究也在逐渐增多。小梁切除术是手术治疗青光眼的经典术式, 该手术能够有效降低眼压、延缓视神经损害的进展, 但其术后低眼压、脉络膜水肿、滤过泡瘢痕化等并发症及术后繁杂的随访、管理给这一术式的进一步发展带来了困难。伴随技术和器械的发展, 上世纪末微创青光眼手术(minimally invasive glaucoma surgery, MIGS)进入临床, MIGS 降眼压效果良好, 手术创伤小, 操作较简单, 并发症少, 前房积血是发生率最高的并发症, 除极少数患者需要前房冲洗外, 大部分患者可自行吸收[54]。目前中国大部分医院小梁切除手术大幅减少, 白内障与青光眼联合手术数量增加, 内引流手术比例增加, 而外引流手术显著减少[3]。临床医生及研究者聚焦于房水引流通路, 在理论与实践不断突破手术难关。伴随着 MIGS 术式的不断涌现, 临床医生面对 OAG 患者拥有越来越多的选择, 如何针对患者病情选择个性化手术治疗成为难点。

通过对现有文献的综合回顾和证据图谱的梳理, 本研究表明手术干预开角型青光眼具有一定的安全性与疗效, 但不同术式疗效存在差异, 且具有一定的局限性。首先, 文献检索可能没有捕获所有新发表

的高质量临床研究, 导致证据缺失。其次, 大多数研究的偏倚风险高, 可能影响结论的准确性。第三, MIGS 手术, 尤其是房水引流通路方面的理论仍在不断创新, 尚有许多谜题未解开, 这制约了对其疗效机制的全面解读和分析。而且部分研究中主要结局指标的缺失也限制了本研究证据图谱的完整性和可靠性。未来的研究应坚持国际报告标准, 促进大样本、多中心临床试验, 并深入研究手术机制, 以明确不同手术方式干预开角型青光眼的适应症及个性化方案, 从而为临床实践提供更高质量的证据支持。

## 参考文献

- [1] 中华医学会眼科学分会青光眼学组, 中国医师协会眼科医师分会青光眼学组. 中国青光眼指南(2020 年) [J]. 中华眼科杂志, 2020, 56(8): 573-586.
- [2] Stein, J.D., Khawaja, A.P. and Weizer, J.S. (2021) Glaucoma in Adults—Screening, Diagnosis, and Management. *JAMA*, **325**, 164-174. <https://doi.org/10.1001/jama.2020.21899>
- [3] Qiao, C., Zhang, H., Cao, K., Tian, J., Chung, T.Y., Shan, J., et al. (2022) Changing Trends in Glaucoma Surgery over the Past 5 Years in China. *Journal of Glaucoma*, **31**, 329-334. <https://doi.org/10.1097/jig.0000000000002004>
- [4] Gedde, S.J., Feuer, W.J., Shi, W., Lim, K.S., Barton, K., Goyal, S., et al. (2018) Treatment Outcomes in the Primary Tube versus Trabeculectomy Study after 1 Year of Follow-Up. *Ophthalmology*, **125**, 650-663. <https://doi.org/10.1016/j.ophtha.2018.02.003>
- [5] Nichani, P., Popovic, M.M., Schlenker, M.B., Park, J. and Ahmed, I.I.K. (2021) Microinvasive Glaucoma Surgery: A Review of 3476 Eyes. *Survey of Ophthalmology*, **66**, 714-742. <https://doi.org/10.1016/j.survophthal.2020.09.005>
- [6] 李艳飞, 李秀霞, 李睿, 等. 证据图谱的制作与报告[J]. 中国循证医学杂志, 2020, 20(9): 1098.
- [7] Ye, W., Li, J., Zhang, S., Zhu, S., Xie, Y., Le, R., et al. (2024) Efficacy and Safety of Penetrating Canaloplasty versus *Ab Externo* Canaloplasty for Primary Open-Angle Glaucoma: A Randomized Controlled Trial. *Acta Ophthalmologica*, **103**, e58-e65. <https://doi.org/10.1111/aos.16750>
- [8] Gallardo, M.J. (2022) 36-Month Effectiveness of *Ab-Interno* Canaloplasty Standalone versus Combined with Cataract Surgery for the Treatment of Open-Angle Glaucoma. *Ophthalmology Glaucoma*, **5**, 476-482. <https://doi.org/10.1016/j.ogla.2022.02.007>
- [9] Liang, Y., Yu, Q., Sun, H., Sucijanti, Gu, L. and Yuan, Z. (2022) Modified Suture-Assisted Canaloplasty in Asians with Primary Open-Angle Glaucoma: A Prospective Study with 12-Month Follow-Up. *BMC Ophthalmology*, **22**, Article No. 202. <https://doi.org/10.1186/s12886-022-02424-9>
- [10] Stingl, J.V., Wagner, F.M., Liebezeit, S., Baumgartner, R., Spät, H., Schuster, A.K., et al. (2023) Long-Term Efficacy and Safety of Modified Canaloplasty versus Trabeculectomy in Open-Angle Glaucoma. *Life*, **13**, Article No. 516. <https://doi.org/10.3390/life13020516>
- [11] Davids, A., Pahlitzsch, M., Boeker, A., Winterhalter, S., Maier-Wenzel, A. and Klamann, M. (2019) *Ab Interno* Canaloplasty (ABIC)—12-Month Results of a New Minimally Invasive Glaucoma Surgery (MIGS). *Graefe's Archive for Clinical and Experimental Ophthalmology*, **257**, 1947-1953. <https://doi.org/10.1007/s00417-019-04366-3>
- [12] Gallardo, M.J., Pyfer, M.F., Vold, S.D., Sarkisian, S., Campbell, A., Singh, I.P., et al. (2022) Canaloplasty and Trabeculectomy Combined with Phacoemulsification for Glaucoma: 12-Month Results of the GEMINI Study. *Clinical Ophthalmology*, **16**, 1225-1234. <https://doi.org/10.2147/opth.s362932>
- [13] Hughes, T. and Traynor, M. (2020) Clinical Results of *Ab Interno* Canaloplasty in Patients with Open-Angle Glaucoma. *Clinical Ophthalmology*, **14**, 3641-3650.
- [14] Sato, T., Kawaji, T., Hirata, A. and Mizoguchi, T. (2018) 360-Degree Suture Trabeculectomy *Ab Interno* to Treat Open-Angle Glaucoma: 2-Year Outcomes. *Clinical Ophthalmology*, **12**, 915-923. <https://doi.org/10.2147/opth.s161238>
- [15] Cubuk, M.O. and Unsal, E. (2020) One-Year Results of Gonioscopy-Assisted Transluminal Trabeculectomy: Evaluation of Prognostic Factors. *European Journal of Ophthalmology*, **31**, 460-468. <https://doi.org/10.1177/1120672120908716>
- [16] Rahmatnejad, K., Pruzan, N.L., Amanullah, S., Shaikat, B.A., Resende, A.F., Waisbourd, M., et al. (2017) Surgical Outcomes of Gonioscopy-Assisted Transluminal Trabeculectomy (GATT) in Patients with Open-Angle Glaucoma. *Journal of Glaucoma*, **26**, 1137-1143. <https://doi.org/10.1097/jig.0000000000000802>
- [17] Vez, S., Müller, L. and Bochmann, F. (2021) Surgical Outcomes of Gonioscopy-Assisted Transluminal Trabeculectomy (GATT) in Patients with Open-Angle Glaucoma—A Retrospective Case Series. *Klinische Monatsblätter für Augenheilkunde*, **238**, 391-395. <https://doi.org/10.1055/a-1425-6888>
- [18] Liu, W.W., Petkovsek, D., Shalaby, W.S., Arbabi, A. and Moster, M.R. (2023) Four-Year Surgical Outcomes of Gonioscopy-Assisted Transluminal Trabeculectomy in Patients with Open-Angle Glaucoma. *Ophthalmology Glaucoma*, **6**, 387-394.

- <https://doi.org/10.1016/j.ogla.2023.01.005>
- [19] Sarkisian Jr., S.R., Mathews, B., Ding, K., Patel, A. and Nicek, Z. (2019) 360° *Ab-Interno* Trabeculotomy in Refractory Primary Open-Angle Glaucoma. *Clinical Ophthalmology*, **13**, 161-168. <https://doi.org/10.2147/oph.s189260>
- [20] Faria, B.M., Costa, V.P., Melillo, G.H.L., Daga, F.B., Scoralick, A.L.B., Paranhos, A., *et al.* (2022) Gonioscopy-Assisted Transluminal Trabeculotomy for Glaucoma: 1-Year Outcomes and Success Predictors. *Journal of Glaucoma*, **31**, 443-448. <https://doi.org/10.1097/ijg.0000000000002025>
- [21] Radcliffe, N.M., Harris, J., Garcia, K., Zwick, E., Chang, R.T. and Mbagwu, M. (2025) Standalone Canaloplasty and Trabeculotomy Using the OMNI Surgical System in Eyes with Primary Open-Angle Glaucoma: A 36-Month Analysis from the American Academy of Ophthalmology IRIS® Registry (Intelligent Research in Sight). *American Journal of Ophthalmology*, **271**, 436-444. <https://doi.org/10.1016/j.ajo.2024.12.015>
- [22] Aktas, Z., Ucgul, A.Y., Bektas, C. and Sahin Karamert, S. (2019) Surgical Outcomes of Prolene Gonioscopy-Assisted Transluminal Trabeculotomy in Patients with Moderate to Advanced Open-Angle Glaucoma. *Journal of Glaucoma*, **28**, 884-888. <https://doi.org/10.1097/ijg.0000000000001331>
- [23] Olgun, A., Aktas, Z. and Ucgul, A.Y. (2020) XEN Gel Implant versus Gonioscopy-Assisted Transluminal Trabeculotomy for the Treatment of Open-Angle Glaucoma. *International Ophthalmology*, **40**, 1085-1093. <https://doi.org/10.1007/s10792-019-01271-w>
- [24] Ruparelia, S., Sharif, M. and Shoham-Hazon, N. (2023) Efficacy and Safety Outcomes of XEN Implantation and Gonioscopy-Assisted Transluminal Trabeculotomy for the Management of Advanced Open-Angle Glaucoma. *Journal of Current Glaucoma Practice*, **17**, 63-67. <https://doi.org/10.5005/jp-journals-10078-1394>
- [25] Olgun, A., Celik, H.U., Yenihayat, F., Bozkurt, E. and Sahbaz, İ. (2022) Efficacy Comparison of Combined Trabeculectomy with MMC and Gonioscopy-Assisted Transluminal Trabeculotomy. *International Ophthalmology*, **42**, 1711-1718. <https://doi.org/10.1007/s10792-021-02166-5>
- [26] Ansari, E. and Loganathan, D. (2021) 12-Month Clinical Outcomes of Combined Phacoemulsification and *Ab Interno* Trabeculectomy for Open-Angle Glaucoma in the United Kingdom. *PLOS ONE*, **16**, e0252826. <https://doi.org/10.1371/journal.pone.0252826>
- [27] Izquierdo, J.C., Mejías, J., Cañola-R, L., Agudelo, N. and Rubio, B. (2020) Primary Outcomes of Combined Cataract Extraction Technique with *Ab-Interno* Trabeculectomy and Endoscopic Cyclophotocoagulation in Patients with Primary Open Angle Glaucoma. *BMC Ophthalmology*, **20**, Article No. 406. <https://doi.org/10.1186/s12886-020-01643-2>
- [28] Zhang, W., Wang, Y., Xin, C., Sun, Y., Cao, K., Wang, H., *et al.* (2021) *Ab Interno* vs. *Ab Externo* Microcatheter-Assisted Circumferential Trabeculotomy in Treating Patients with Primary Open-Angle Glaucoma. *Frontiers in Medicine*, **8**, Article 795172. <https://doi.org/10.3389/fmed.2021.795172>
- [29] Kono, Y., Kasahara, M., Hirasawa, K., Tsujisawa, T., Kanayama, S., Matsumura, K., *et al.* (2020) Long-Term Clinical Results of Trabectome Surgery in Patients with Open-Angle Glaucoma. *Graefe's Archive for Clinical and Experimental Ophthalmology*, **258**, 2467-2476. <https://doi.org/10.1007/s00417-020-04897-0>
- [30] Kono, Y., Kasahara, M., Sato, N., Yokozeki, Y., Hirasawa, K. and Shoji, N. (2023) Comparison of Short-Term Visual Acuity Changes after Trabeculotomy *Ab Interno* Using Trabectome and Trabeculectomy *Ab Externo*. *Ophthalmology Glaucoma*, **6**, 609-615. <https://doi.org/10.1016/j.ogla.2023.05.002>
- [31] Wang, L., Wang, C., Wang, P., Dai, C., Kurmi, R., Zhang, W., *et al.* (2024) Comparison of Efficacy and Safety between Gonioscopy-Assisted Transluminal Trabeculotomy and Trabeculectomy for Primary Open-Angle Glaucoma Treatment: A Retrospective Cohort Study. *BMC Ophthalmology*, **24**, Article No. 533. <https://doi.org/10.1186/s12886-024-03798-8>
- [32] Baker, N.D., Barnebey, H.S., Moster, M.R., Stiles, M.C., Vold, S.D., Khatana, A.K., *et al.* (2021) *Ab-Externo* Microshunt versus Trabeculectomy in Primary Open-Angle Glaucoma: One-Year Results from a 2-Year Randomized, Multicenter Study. *Ophthalmology*, **128**, 1710-1721. <https://doi.org/10.1016/j.ophtha.2021.05.023>
- [33] Avar, M., Jordan, J.F., Neuburger, M., Engesser, D., Lübke, J., Anton, A., *et al.* (2019) Long-Term Follow-Up of Intraocular Pressure and Pressure-Lowering Medication in Patients after *Ab-Interno* Trabeculectomy with the Trabectome. *Graefe's Archive for Clinical and Experimental Ophthalmology*, **257**, 997-1003. <https://doi.org/10.1007/s00417-019-04259-5>
- [34] Greenwood, M., Yadgarov, A., Flowers, B., Sarkisian Jr., S., Ohene-Nyako, A. and Dickerson Jr., J. (2023) 36-Month Outcomes from the Prospective GEMINI Study: Canaloplasty and Trabeculotomy Combined with Cataract Surgery for Patients with Primary Open-Angle Glaucoma. *Clinical Ophthalmology*, **17**, 3817-3824. <https://doi.org/10.2147/oph.s446486>
- [35] Ruparelia, S., Wilson, D. and Shoham-Hazon, N. (2023) Hemi-Gatt Combined with Phacoemulsification in Patients with Moderate-Severe Primary Open-Angle Glaucoma: 2-Year Outcomes. *Graefe's Archive for Clinical and Experimental Ophthalmology*, **261**, 3257-3262. <https://doi.org/10.1007/s00417-023-06166-2>
- [36] Hamze, H., Mohite, A.A., Pandey, P., Sung, V.C.T. and Masood, I. (2021) Comparison of 1-Year Surgical Outcomes of Combined Cataract Surgery and Gonioscopy-Assisted Transluminal Trabeculotomy (GATT) versus Cataract Surgery and IStent Inject. *Graefe's Archive for Clinical and Experimental Ophthalmology*, **259**, 3035-3044. <https://doi.org/10.1007/s00417-021-05133-z>

- [37] Akil, H., Chopra, V., Huang, A.S., Swamy, R. and Francis, B.A. (2017) Short-Term Clinical Results of *Ab Interno* Trabeculotomy Using the Trabectome with or without Cataract Surgery for Open-Angle Glaucoma Patients of High Intraocular Pressure. *Journal of Ophthalmology*, 2017, Article ID: 8248710. <https://doi.org/10.1155/2017/8248710>
- [38] Loayza-Gamboa, W., Martel-Ramirez, V., Inga-Condezo, V., Valderrama-Albino, V., Alvarado-Villacorta, R. and Valera-Cornejo, D. (2020) Outcomes of Combined Prolene Gonioscopy Assisted Transluminal Trabeculotomy with Phacoemulsification in Open-Angle Glaucoma. *Clinical Ophthalmology*, 14, 3009-3016. <https://doi.org/10.2147/opth.s272298>
- [39] Yadgarov, A., Dentice, K. and Aljabi, Q. (2023) Real-World Outcomes of Canaloplasty and Trabeculotomy Combined with Cataract Surgery in Eyes with All Stages of Open-Angle Glaucoma. *Clinical Ophthalmology*, 17, 2609-2617. <https://doi.org/10.2147/opth.s422132>
- [40] Hashemian, S.J., Miraftabi, A., Jafari, M.E. and Hemami, M.R. (2017) Combined Cataract Extraction and Trabeculotomy by the Internal Approach for Coexisting Cataract and Open-Angle Glaucoma. *Journal of Current Ophthalmology*, 29, 17-22. <https://doi.org/10.1016/j.joco.2016.09.003>
- [41] Poroy, C., Baykara, M. and Erseven, C. (2019) Surgical Outcomes of Combined Gonioscopy-Assisted Transluminal Trabeculotomy and Cataract Surgery. *Indian Journal of Ophthalmology*, 67, 505-508. [https://doi.org/10.4103/ijo.ijo\\_1007\\_18](https://doi.org/10.4103/ijo.ijo_1007_18)
- [42] Sasidharan, A., Shah, P. and Thulasidas, M. (2024) Short-term Outcomes of Tanito Microhook *Ab Interno* Trabeculotomy Combined with Phacoemulsification in Primary Open-Angle Glaucoma—A Pilot Study. *Indian Journal of Ophthalmology*, 73, S250-S253. [https://doi.org/10.4103/ijo.ijo\\_723\\_24](https://doi.org/10.4103/ijo.ijo_723_24)
- [43] Maheshwari, D., Pillai, M.R., Nagdev, N.G., Gupta, S., Ramakrishnan, R., Kader, M.A., et al. (2024) Early Outcomes of 5-0 Prolene Gonioscopy-Assisted Transluminal Trabeculotomy Combined with Phacoemulsification in Eyes of Indian Glaucoma Patients. *Indian Journal of Ophthalmology*, 73, S287-S292. [https://doi.org/10.4103/ijo.ijo\\_3065\\_23](https://doi.org/10.4103/ijo.ijo_3065_23)
- [44] Chen, Y., Song, A., Jin, W., Yang, X. and Dang, G. (2020) *Ab Interno* Trabeculotomy Combined with Cataract Extraction in Eyes with Primary Open-Angle Glaucoma. *Journal of International Medical Research*, 48, 1-9. <https://doi.org/10.1177/0300060520957447>
- [45] Sato, T., Kawaji, T., Hirata, A. and Mizoguchi, T. (2018) 360-Degree Suture Trabeculotomy *Ab Interno* with Phacoemulsification in Open-Angle Glaucoma and Coexisting Cataract: A Pilot Study. *BMJ Open Ophthalmology*, 3, e000159. <https://doi.org/10.1136/bmjophth-2018-000159>
- [46] Koylu, M.T., Yilmaz, A.C., Gurdal, F., Ozge, G., Sagdani, A., Demir, S., et al. (2025) Kahook Dual Blade Goniotomy Combined with Phacoemulsification in Eyes with Primary Open Angle Glaucoma and Pseudoexfoliation Glaucoma: Comparative Study. *BMC Ophthalmology*, 25, Article No. 184. <https://doi.org/10.1186/s12886-025-04026-7>
- [47] Hirsch, L., Cotliar, J., Vold, S., Selvadurai, D., Campbell, A., Ferreira, G., et al. (2021) Canaloplasty and Trabeculotomy *Ab Interno* with the OMNI System Combined with Cataract Surgery in Open-Angle Glaucoma: 12-Month Outcomes from the ROMEO Study. *Journal of Cataract & Refractive Surgery*, 47, 907-915. <https://doi.org/10.1097/j.jcrs.0000000000000552>
- [48] Lin, H., Zhou, W., Li, J., Ye, W., Zheng, X., Lei, C., et al. (2024) Surgical Outcomes of XEN45 Implantation, Trabeculotomy vs. Penetrating Canaloplasty in Open-Angle Glaucoma: A Non-Randomized Comparative Study. *Chinese Medical Journal*, 137, 1999-2001. <https://doi.org/10.1097/cm9.0000000000003128>
- [49] Magacho, L., Franco, C.G.V.d.S., I, E.A., Pereira, A.C.A., Teno, B., Lucena-Neto, F., et al. (2024) Gonioscopy-Assisted Transluminal Trabeculotomy Outcomes under Different Levels of Glaucoma Severity: A Multicenter, Comparative Study. *American Journal of Ophthalmology*, 264, 75-84. <https://doi.org/10.1016/j.ajo.2024.02.033>
- [50] Rauegger, T., Krause, S., Nowosielski, Y., Huber, A.L., Willeit, P., Schmid, E., et al. (2024) Three-Year Clinical Outcome of XEN45 Gel Stent Implantation versus Trabeculectomy in Patients with Open Angle Glaucoma. *Eye*, 38, 1908-1916. <https://doi.org/10.1038/s41433-024-03042-z>
- [51] 刘岳峰. 房角镜辅助的 360°小梁切开术治疗中晚期原发性开角型青光眼患者的疗效观察[D]: [硕士学位论文]. 南昌: 南昌大学, 2024.
- [52] 赵茹梦, 崔慧玲, 任静, 等. XEN 引流管植入联合丝裂霉素 C 治疗开角型青光眼[J]. 国际眼科杂志, 2024, 24(6): 965-969.
- [53] 张禹乔. Ex-PRESS 青光眼引流钉治疗合并白内障的原发性开角型青光眼[D]: [硕士学位论文]. 汕头: 汕头大学, 2021.
- [54] Vinod, K. and Gedde, S.J. (2020) Safety Profile of Minimally Invasive Glaucoma Surgery. *Current Opinion in Ophthalmology*, 32, 160-168. <https://doi.org/10.1097/icu.0000000000000731>