

人工晶状体巩膜固定术的研究进展

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摘 要

在各种原因(外伤、术中后囊膜破裂、晶状体脱位等)导致的无充足囊袋支撑的情况下, 常规的人工晶状体(Intraocular lens, IOL)植入方案实施困难。房角支撑型IOL和虹膜夹持型IOL因其较多的并发症现已不作为常规选择, 因此, IOL巩膜固定术成为目前无充足囊膜支撑时的主流术式。从有缝线的IOL巩膜悬吊到无缝线的IOL巩膜层间固定, 再到新型巩膜固定IOL的研发, 术者们致力于提高手术效果的同时简化手术操作和减少术后并发症的发生, IOL巩膜固定手术技术得以不断改进, 本文就IOL巩膜固定术的进展进行综述。

关键词

无晶状体, 囊膜支撑不足, 二期人工晶状体植入, 人工晶状体巩膜固定术

Review of the Advancements in Scleral Fixation Techniques for Intraocular Lenses

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Abstract

Conventional intraocular lens (IOL) implantation is challenging in cases where sufficient capsular

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support is compromised due to various factors, such as trauma, intraoperative capsular rupture or lens dislocation. Angle-supported anterior chamber IOL and iris-clamp IOL are not standard options due to their associated complications. As a result, scleral fixation of the IOL has become the predominant choice in scenarios without sufficient capsular support. The evolution from sutured scleral suspension techniques for IOL to sutureless interscleral fixation methods and the introduction of novel scleral fixation IOL designs reflects surgeons' efforts to improve surgical outcomes, streamline procedures and minimize postoperative complications. As a result, surgical techniques for scleral fixation of IOL continue to evolve. This article provides an overview of recent developments in scleral fixation of IOL.

Keywords

Aphakia, Insufficient Capsular Support, Secondary IOL Implant, Scleral Fixation of IOL

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1. 背景

白内障超声乳化摘除联合人工晶状体(Intraocular lens, IOL)囊袋内植入是白内障的首选治疗方案,但在各种原因(外伤、术中后囊膜破裂、晶状体脱位等)导致的无充足囊袋支撑的情况下,常规的 IOL 植入方案实施困难。为克服这一难题,先后出现了多种替代治疗方案。佩戴框架眼镜是最简单的解决方式,价格便宜,简单易行,但高度正球面镜片会导致物像放大,单眼佩戴时双眼不等像,难以形成双眼单视[1]。角膜接触镜能够一定程度减轻物像放大的比例,但佩戴和护理相对复杂。因此,在临床已少有应用。IOL 眼内植入更符合眼部生理解剖,能达到更好的矫正效果。根据植入部位不同可分为房角支撑、虹膜固定和巩膜固定[2]。房角支撑是将前房型 IOL 直接植入前房, IOL 襻固定于房角,手术简单易行[2][3]。早期的闭环型前房 IOL 因众多的不良反应已不再使用,改良后的开环型前房 IOL 一定程度减轻了与房角的接触和对角膜内皮和虹膜的摩擦,但因其潜在的继发性青光眼和角膜内皮失代偿风险,现已很少使用[3][4]。虹膜固定型包括虹膜悬吊或虹膜夹持(Artisan 虹膜夹型 IOL),固定于虹膜前后表面均可,相对于房角支撑型,有效降低了对角膜内皮和房角的影响,但依赖于虹膜组织的支撑,远期易出现瞳孔异常、虹膜色素播散和 IOL 脱位等并发症[5][6]。经巩膜固定的 IOL 悬吊术将 IOL 固定于睫状体平坦部,更符合眼部生理结构,且有效降低了对角膜内皮、房角及虹膜的影响,是目前囊膜支撑不足的无晶状体眼的主流治疗方案,包括有缝线的 IOL 巩膜悬吊术和无缝线的 IOL 巩膜层间固定术[7]。本文将对 IOL 巩膜固定术的进展进行综述。

2. 有缝线的 IOL 巩膜悬吊术

有缝线的 IOL 巩膜悬吊术由 Malbran 于 1986 年提出[8]。通过缝线将 IOL 悬吊于睫状体平坦部巩膜,有效地降低了对角膜内皮细胞、房角结构和虹膜组织的损伤,但手术操作相对复杂,对术者要求较高。远期缝线线结暴露可导致局部炎症,缝线断裂可导致 IOL 脱位等并发症,因此,许多术者对其进行了相应的技术改良。

2.1. 线结埋藏技术

在进行 IOL 巩膜悬吊时,10-0 聚丙烯缝线最为常用,为减少远期缝线断裂的风险,更粗的缝线也有

应用,如 9-0、8-0 聚丙烯缝线和 8-0 聚四氟乙烯缝线(Gore-Tex)等[9]。早期的术式中巩膜外线结由结膜覆盖,随着时间推移存在极大的线结暴露风险。通过制备巩膜沟[10]、巩膜瓣[11]或巩膜袋进[12] [13]行缝线和线结埋藏、将线结旋转至眼内[14]等改良手术方案的提出,一定程度上降低了线结暴露的概率。李保江等[15] [16]报道了一种无巩膜瓣单线结缝合技术(用于经巩膜固定 4 襻和 C 形襻 IOL 的新型手术技术),有效地简化了手术方式。金海鹰等[17] [18]报道的巩膜内线结埋藏法在简化手术方式的同时一定程度上解决了线结暴露问题,在术后平均 10 个月的随访周期内,IOL 稳定性良好,未观察到缝线暴露和断裂。

2.2. 无线结的“Z”字缝合技术

虽然各种线结埋藏技术的改良有效减少了线结的暴露,但潜在的风险仍然存在。Szurman 等[19]于 2010 年首次报道了一种采用 10-0 聚乙烯缝线按“Z”字形于巩膜组织内反折穿行 5 次用于替代打结固定的方法,不需要制备巩膜瓣和埋藏线结,直接利用缝线与巩膜组织间的摩擦力进行 IOL 悬吊。在平均 22.4 个月的随访期内,采用该技术进行 IOL 悬吊的 45 例患者均未出现 IOL 倾斜和缝线松动。Yilmaz 等[20]报道与有线结的巩膜 IOL 悬吊术相比,在平均 4 年的随访期内,“Z”字缝合技术疗效类似,但更少出现缝线暴露。近期的几项回顾性分析也显示了巩膜“Z”字缝合技术在用于 IOL 悬吊的安全性和有效性[21]-[23]。

3. 无缝线的 IOL 巩膜层间固定术

在 IOL 悬吊的手术方式中,由于巩膜缝线的存在,缝线断裂和暴露的相关风险始终存在。因此,近年来,为避免缝线相关的并发症,无缝线的 IOL 巩膜层间固定术被提出并受到了广泛关注。

3.1. 巩膜隧道固定术

Gabor 等人[24] 2007 年报道了一种 3 片式 IOL 巩膜层间固定术。通过在角膜缘后 1.5~2.0 mm 处做两个对称的巩膜切口,并用 24G 穿刺针沿巩膜切口平行于角膜缘做 2.0~3.0 mm 的巩膜隧道,深度约 50%,推注器通过小切口植入后,将 IOL 襻引入巩膜隧道进行巩膜层间固定。一项包括欧洲 4 个眼科中心的回顾性研究结果显示,在平均 7 个月的随访期内,63 例接受该技术进行 IOL 巩膜层间固定的患者中,61 (96.8%)例患者 IOL 稳定且居中性良好,无复发性脱位、眼内炎、视网膜脱离或青光眼的病例[25]。但该技术巩膜切口和隧道入口相邻,将襻引入隧道操作难度较大[26]。因此,Totan 等人[27]对该技术进行了改良,采用 23G/25G 穿刺套管在角膜缘后 1.5 mm 处同一径向上制作 2 个长 3 mm 的巩膜隧道穿刺口,与角膜缘相平行,IOL 经小切口植入眼内并通过 23G/25G 镊子夹住襻连同套管一起拔出,即可将襻引入隧道。与 Gabor 的术式相比,该手术技术操作更简单,对结膜的损伤更小,对比研究结果显示两种术式手术效果和并发症的发生率类似[26]。

3.2. 纤维蛋白胶粘合术

纤维蛋白胶作为组织粘合剂,有研究报道在板层角膜移植术、小梁切除术和白内障手术切口闭合中成功应用[28]。为了避免缝线相关的并发症,Agarwal 等人[29]提出采用纤维蛋白胶替代缝线进行 IOL 固定后的巩膜、结膜切口闭合,有效缩短了手术时间。术后随访结果显示,与缝线组对比,术后 6 个月时视力恢复类似,但纤维蛋白胶组术后炎症等并发症的发生率更低(28% vs. 56%)。之后,为了简化手术操作,Agarwal 等人还进一步改进了襻外化的步骤,并将其描述了“握手技术”[30] [31]。

3.3. Yamane 技术

Yamane 等人[32]在 2016 年美国白内障和屈光手术学会年会上报道了一种新的无缝线 IOL 巩膜层间

固定技术, 该技术通过 30G 针头在角膜缘后方 2 mm 处做巩膜隧道进入眼内, 通过针头见襻引出, 使用烧灼器烧灼襻末端形成一个直径 0.3 mm 的球状凸起, 然后将襻回推使球状突起固定在巩膜隧道中, 不需要缝线或纤维蛋白胶闭合切口。在一项纳入 97 例患者的前瞻性临床研究中, 患者术后视力明显改善, 术后 3 个月时 IOL 平均倾斜度为 $3.4^{\circ} \pm 2.5^{\circ}$, 与目标屈光度的误差为 0.21 ± 0.99 D, 在约 20 个月的平均随访时间内, 无视网膜脱离、IOL 脱位和眼内炎等并发症发生[32]。为了确保 30G 针头的插入位置和角度准确, Yamane 等人[33]还发明了一款针稳定器, 确保针头从角膜缘后 2 mm 处制备巩膜隧道, 并保持与角膜缘成 20° , 与虹膜表面成 10° , 有效地提高了手术的精准度。在此基础上, 其他术者还报道了对该技术的改良, 包括穿刺套管辅助襻外化技术、扁平法兰技术、双法兰技术、四法兰技术等[34]。近期的一项系统回顾结果显示, Yamane 技术与传统的缝线 IOL 巩膜固定术表现出相似的长期视觉效果和并发症发生率, 但 Yamane 技术组手术时间更短, 术后视力恢复时间更短[35]。

3.4. 新型巩膜内固定 IOL

为克服三片式的 IOL 无缝线巩膜层间固定操作复杂、学习曲线较长等问题, Madanagopalan 团队[36] 2020 年开发了一种新型的 IOL: CM-T Flex IOL (图 1(A), 图 1(B)), 是一种一片式可折叠亲水性丙烯酸酯 IOL, 具有 2 个 T 形的襻, 总直径 13.75 mm。术中在 3 点和 9 点钟位制备巩膜瓣和巩膜隧道, IOL 通过 2.8 mm 的角膜切口植入, 并用专门设计的 PraNiv T Flex 镊子将襻通过巩膜隧道引出, 巩膜瓣和周围组织用纤维蛋白胶粘合, 无需缝合。在对 57 眼接受 CM-T Flex IOL 超过 3 年的随访周期内, 患者视力得到了显著改善, IOL 稳定性良好, 没有观察到 IOL 偏心、脱位和襻暴露等并发症[37][38]。Veronese 等人[39]也于 2020 年报道了另一种新型一片式可折叠亲水性丙烯酸酯 IOL: FIL SSF Carlevale IOL (图 1(C)), 在两侧襻的末端设计有柔性的角巩膜塞结构, 总长度 13.2 mm。首先进行标准的 25G 三通道玻璃体切割术, IOL 通过 2.75 mm 的角膜切口植入, 25G 视网膜镊夹住 IOL 的前角巩膜塞, 随后在视网膜镊连同玻切套管一起从眼内抽出的同时将角巩膜塞引出, 采用同样的方法引出另一侧的角巩膜塞, 最后移除玻切套管, 确认巩膜穿刺口无渗漏, 无需缝合。最近的一项文献综述和系统评价结果均显示了 Carlevale IOL 良好的安全性和有效性[40][41]。与三片式 IOL 巩膜悬吊术相比, Carlevale IOL 植入术后视力恢复、屈光误差、IOL 倾斜程度和全眼像差无显著差异[42][43]。与虹膜夹持型 IOL 植入术相比, Carlevale IOL 植入术后患者的视力恢复相似, 但表现出更低的屈光不正和术源性散光[44]。

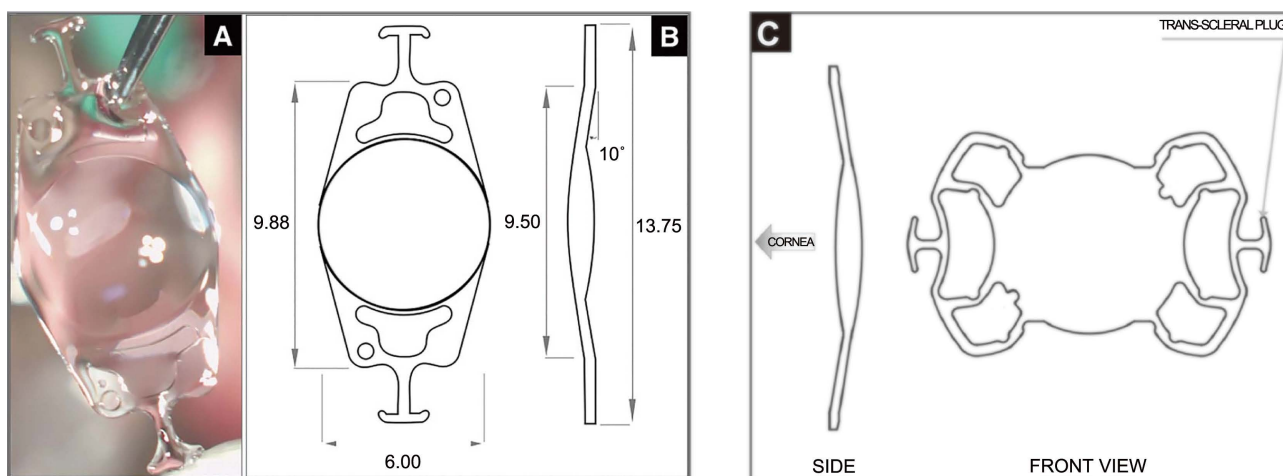


Figure 1. New lens for suture-less scleral fixation [36] [39]. A, B: CM-T Flex IOL, C: FIL SSF Carlevale IOL

图 1. 新型巩膜内固定 IOL [36] [39]。A, B: CM-T Flex IOL, C: FIL SSF Carlevale IOL

4. 小结

IOL 巩膜固定作为目前无充足囊膜支撑状态下的主流术式, 其手术技术得到了不断地改良和发展。从有缝线的 IOL 巩膜悬吊术到无缝线的 IOL 巩膜层间固定, 再到新型巩膜固定 IOL 开发, 术者们致力于提高手术效果的同时简化手术操作、减少术后并发症的发生。各种不同的术式各有优缺点, 在实际的临床工作中, 术者需根据患者的实际情况以及个人的手术经验进行选择。

参考文献

- [1] Dabiezies, O.H. (1979) Defects of Vision through Aphakic Spectacle Lenses. *Ophthalmology*, **86**, 352-379. [https://doi.org/10.1016/s0161-6420\(79\)35503-8](https://doi.org/10.1016/s0161-6420(79)35503-8)
- [2] Dick, H.B. and Augustin, A.J. (2001) Lens Implant Selection with Absence of Capsular Support. *Current Opinion in Ophthalmology*, **12**, 47-57. <https://doi.org/10.1097/00055735-200102000-00009>
- [3] Wagoner, M.D., Cox, T.A., Ariyasu, R.G., Jacobs, D.S. and Karp, C.L. (2003) Intraocular Lens Implantation in the Absence of Capsular Support: A Report by the American Academy of Ophthalmology. *Ophthalmology*, **110**, 840-859. [https://doi.org/10.1016/s0161-6420\(02\)02000-6](https://doi.org/10.1016/s0161-6420(02)02000-6)
- [4] Negretti, G.S., Lai, M., Petrou, P., Walker, R. and Charteris, D. (2017) Anterior Chamber Lens Implantation in Vitrectomised Eyes. *Eye*, **32**, 597-601. <https://doi.org/10.1038/eye.2017.261>
- [5] Toro, M.D., Longo, A., Avitabile, T., Nowomiejska, K., Gagliano, C., Tripodi, S., *et al.* (2019) Five-Year Follow-Up of Secondary Iris-Claw Intraocular Lens Implantation for the Treatment of Aphakia: Anterior Chamber versus Retropupillary Implantation. *PLOS ONE*, **14**, e0214140. <https://doi.org/10.1371/journal.pone.0214140>
- [6] Choi, E.Y., Lee, C.H., Kang, H.G., Han, J.Y., Byeon, S.H., Kim, S.S., *et al.* (2021) Long-Term Surgical Outcomes of Primary Retropupillary Iris Claw Intraocular Lens Implantation for the Treatment of Intraocular Lens Dislocation. *Scientific Reports*, **11**, Article No. 726. <https://doi.org/10.1038/s41598-020-80292-3>
- [7] Shahid, S.M., Flores-Sánchez, B.C., Chan, E.W., Anguita, R., Ahmed, S.N., Wickham, L., *et al.* (2021) Scleral-Fixated Intraocular Lens Implants—Evolution of Surgical Techniques and Future Developments. *Eye*, **35**, 2930-2961. <https://doi.org/10.1038/s41433-021-01571-5>
- [8] Malbran, E.S., Malbran, E. and Negri, I. (1986) Lens Guide Suture for Transport and Fixation in Secondary IOL Implantation after Intracapsular Extraction. *International Ophthalmology*, **9**, 151-160. <https://doi.org/10.1007/bf00159844>
- [9] Stem, M.S., Todorich, B., Woodward, M.A., Hsu, J. and Wolfe, J.D. (2017) Scleral-Fixated Intraocular Lenses: Past and Present. *Journal of VitreoRetinal Diseases*, **1**, 144-152. <https://doi.org/10.1177/2474126417690650>
- [10] Lin, C. and Tseng, H. (2004) Suture Fixation Technique for Posterior Chamber Intraocular Lenses. *Journal of Cataract and Refractive Surgery*, **30**, 1401-1404. <https://doi.org/10.1016/j.jcrs.2003.11.044>
- [11] Kjekka, O., Bohnstedt, J., Meberg, K. and Seland, J.H. (2008) Implantation of Scleral-Fixated Posterior Chamber Intraocular Lenses in Adults. *Acta Ophthalmologica*, **86**, 537-542. <https://doi.org/10.1111/j.1600-0420.2007.01095.x>
- [12] Hoffman, R.S., Fine, H.I. and Packer, M. (2006) Scleral Fixation without Conjunctival Dissection. *Journal of Cataract and Refractive Surgery*, **32**, 1907-1912. <https://doi.org/10.1016/j.jcrs.2006.05.029>
- [13] Potemkin, V., Astakhov, S., Goltsman, E. and Yuan, V.S. (2022) Limbal Mini-Pockets for Transscleral IOL Fixation. *Advances in Ophthalmology Practice and Research*, **2**, Article ID: 100044. <https://doi.org/10.1016/j.aopr.2022.100044>
- [14] Baykara, M. and Avci, R. (2004) Prevention of Suture Knot Exposure in Posterior Chamber Intraocular Lens Implantation by 4-Point Scleral Fixation Technique. *Ophthalmic Surgery, Lasers and Imaging Retina*, **35**, 379-382. <https://doi.org/10.3928/1542-8877-20040901-06>
- [15] Li, B., Zhang, Y. and Gao, X. (2019) Simple Technique for Transscleral Fixation of a Foldable Posterior Chamber Intraocular Lens Using a Single Suture. *Journal of Investigative Surgery*, **33**, 446-452. <https://doi.org/10.1080/08941939.2018.1535011>
- [16] Long, Q. (2023) Flapless One-Knot Suture: A Novel Surgical Technique for Transscleral Fixation of C-Loop Intraocular Lenses. *International Journal of Ophthalmology*, **16**, 736-742. <https://doi.org/10.18240/ijo.2023.05.10>
- [17] Hu, X., Zhao, B. and Jin, H. (2020) Intrasceral Suture Anchoring: A Flapless/Grooveless Four-Point Intraocular Lens Fixation Technique. *Journal of Ophthalmology*, **2020**, Article ID: 6642007. <https://doi.org/10.1155/2020/6642007>
- [18] Jin, H. and Zhang, Q. (2023) Flapless Intrasceral Knotting Technique for Suture Fixation of Intraocular Implants. *Retina*, **43**, 1031-1034. <https://doi.org/10.1097/iae.0000000000002895>
- [19] Szurman, P., Petermeier, K., Aisenbrey, S., Spitzer, M.S. and Jaissle, G.B. (2010) Z-Suture: A New Knotless Technique

- for Transscleral Suture Fixation of Intraocular Implants. *British Journal of Ophthalmology*, **94**, 167-169. <https://doi.org/10.1136/bjo.2009.162180>
- [20] Yilmaz, S., Mavi Yildiz, A. and Avci, R. (2021) A Comparative Study of Knotless versus Knotted Transscleral Suture-Fixated Intraocular Lens Implantation. *Indian Journal of Ophthalmology*, **70**, 131-137. https://doi.org/10.4103/ijo.ijo_551_21
- [21] Dinç, E., Vatansever, M., Dursun, Ö., Gökem Markirt, H., Aydın, B., Yılmaz, A., *et al.* (2017) Scleral Fixated Intraocular Lens Implantation with a Modified Z-Suture Technique. *International Ophthalmology*, **38**, 2357-2361. <https://doi.org/10.1007/s10792-017-0735-8>
- [22] Kandemir Beşek, N., Alagoz, N., Gumus, G., Kepez Yildiz, B., Kirgiz, A., Yildirim, Y., *et al.* (2020) Long-Term Results of Aphakia Management by Scleral Fixation Intraocular Lens Placement with Knotless Transscleral Z-Suture Method. *International Ophthalmology*, **40**, 1449-1454. <https://doi.org/10.1007/s10792-020-01311-w>
- [23] Barbosa, R.C. and Carvalho, R. (2024) Z-Suture Scleral Fixation Intraocular Lenses: A Refractive and Safety Report. *European Journal of Ophthalmology*, **34**, 1884-1889. <https://doi.org/10.1177/11206721241230566>
- [24] Gabor, S.G.B. and Pavlidis, M.M. (2007) Sutureless Intrasceral Posterior Chamber Intraocular Lens Fixation. *Journal of Cataract and Refractive Surgery*, **33**, 1851-1854. <https://doi.org/10.1016/j.jcrs.2007.07.013>
- [25] Scharioth, G.B., Prasad, S., Georgalas, I., Tataru, C. and Pavlidis, M. (2010) Intermediate Results of Sutureless Intrasceral Posterior Chamber Intraocular Lens Fixation. *Journal of Cataract and Refractive Surgery*, **36**, 254-259. <https://doi.org/10.1016/j.jcrs.2009.09.024>
- [26] Totan, Y. and Karadag, R. (2013) Two Techniques for Sutureless Intrasceral Posterior Chamber IOL Fixation. *Journal of Refractive Surgery*, **29**, 90-94. <https://doi.org/10.3928/1081597x-20130117-02>
- [27] Totan, Y. and Karadag, R. (2012) Trocar-Assisted Sutureless Intrasceral Posterior Chamber Foldable Intra-Ocular Lens Fixation. *Eye*, **26**, 788-791. <https://doi.org/10.1038/eye.2012.19>
- [28] Hovanesian, J.A. and Karageozian, V.H. (2007) Watertight Cataract Incision Closure Using Fibrin Tissue Adhesive. *Journal of Cataract and Refractive Surgery*, **33**, 1461-1463. <https://doi.org/10.1016/j.jcrs.2007.03.060>
- [29] Agarwal, A., Kumar, D.A., Jacob, S., Baid, C., Agarwal, A. and Srinivasan, S. (2008) Fibrin Glue-Assisted Sutureless Posterior Chamber Intraocular Lens Implantation in Eyes with Deficient Posterior Capsules. *Journal of Cataract and Refractive Surgery*, **34**, 1433-1438. <https://doi.org/10.1016/j.jcrs.2008.04.040>
- [30] Agarwal, A., Jacob, S., Kumar, D.A., Agarwal, A., Narasimhan, S. and Agarwal, A. (2013) Handshake Technique for Glued Intrasceral Haptic Fixation of a Posterior Chamber Intraocular Lens. *Journal of Cataract and Refractive Surgery*, **39**, 317-322. <https://doi.org/10.1016/j.jcrs.2013.01.019>
- [31] Kumar, D.A. and Agarwal, A. (2013) Glued Intraocular Lens: A Major Review on Surgical Technique and Results. *Current Opinion in Ophthalmology*, **24**, 21-29. <https://doi.org/10.1097/icu.0b013e32835a939f>
- [32] Yamane, S., Sato, S., Maruyama-Inoue, M. and Kadosono, K. (2017) Flanged Intrasceral Intraocular Lens Fixation with Double-Needle Technique. *Ophthalmology*, **124**, 1136-1142. <https://doi.org/10.1016/j.ophtha.2017.03.036>
- [33] Yamane, S., Maruyama-Inoue, M. and Kadosono, K. (2019) Needle Stabilizer for Flanged Intraocular Lens Fixation. *Retina*, **39**, 801-801. <https://doi.org/10.1097/iae.0000000000002455>
- [34] Yamane, S. and Ito, A. (2020) Flanged Fixation: Yamane Technique and Its Application. *Current Opinion in Ophthalmology*, **32**, 19-24. <https://doi.org/10.1097/icu.0000000000000720>
- [35] Zhang, C., Palka, C., Zhu, D., Lai, D., Winokur, J., Shwani, T., *et al.* (2024) Clinical Outcomes in Scleral Fixation Secondary Intraocular Lens with Yamane versus Suture Techniques: A Systematic Review and Meta-Analysis. *Journal of Clinical Medicine*, **13**, Article No. 3071. <https://doi.org/10.3390/jcm13113071>
- [36] Madhivanan, N., Nivean, P.D., Aysha, P.A.P., Arthi, M. and Madanagopalan, V.G. (2020) Innovative Intraocular Lens Design to Manage Surgical Aphakia in an Eye with a Filtering Bleb. *Journal of Cataract and Refractive Surgery*, **46**, 1564-1567. <https://doi.org/10.1097/j.jcrs.0000000000000292>
- [37] Madanagopalan, V.G., Madhivanan, N. and Selvam, V.P. (2020) A Novel Sutureless Scleral-Fixated Lens That Eliminates Extra Ocular Haptic Manipulation: The CM-T Flex Lens. *Ophthalmic Surgery, Lasers and Imaging Retina*, **51**, 648-650. <https://doi.org/10.3928/23258160-20201104-07>
- [38] Madhivanan, N., Nivean, P.D., Singh, V., Singh, H., Arthi, M. and Madanagopalan, V.G. (2024) Long Term Surgical Results and Safety Profile of the Novel CM T Flex Scleral Fixated Intraocular Lens. *International Ophthalmology*, **44**, Article No. 327. <https://doi.org/10.1007/s10792-024-03167-w>
- [39] Veronese, C., Maiolo, C., Armstrong, G.W., Primavera, L., Torrazza, C., Della Mora, L., *et al.* (2020) New Surgical Approach for Sutureless Scleral Fixation. *European Journal of Ophthalmology*, **30**, 612-615. <https://doi.org/10.1177/1120672120902020>
- [40] Carlà, M.M., Boselli, F., Giannuzzi, F., Caporossi, T., Gambini, G., Mosca, L., *et al.* (2022) Sutureless Scleral Fixation

- Carlevale IOL: A Review on the Novel Designed Lens. *International Ophthalmology*, **43**, 2129-2138. <https://doi.org/10.1007/s10792-022-02579-w>
- [41] Barbieri, F., Maglionico, M.N., Casini, G., Guidi, G., Figus, M. and Posarelli, C. (2024) Current Evidence for a New Surgical Technique for Scleral Fixation: The Implantation of a Carlevale Lens, a Systematic Review. *Journal of Clinical Medicine*, **13**, Article No. 3287. <https://doi.org/10.3390/jcm13113287>
- [42] Raimondi, R., Sorrentino, T., Kilian, R., Verma, Y., De Rosa, F.P., Cancian, G., *et al.* (2023) Trans-Scleral Plugs Fixated FIL SSF IOL: A Review of the Literature and Comparison with Other Secondary IOL Implants. *Journal of Clinical Medicine*, **12**, Article No. 1994. <https://doi.org/10.3390/jcm12051994>
- [43] Franco, F., Serino, F., Vicini, G., Nicolosi, C. and Giansanti, F. (2022) Comparison of Visual and Aberrometric Outcomes in Suture-Free Scleral Fixation: Three-Piece Lenses versus Carlevale Lenses. *Journal of Clinical Medicine*, **12**, Article No. 188. <https://doi.org/10.3390/jcm12010188>
- [44] Seknazi, D., Colantuono, D., Tahiri, R., Amoroso, F., Miere, A. and Souied, E.H. (2021) Secondary Sutureless Posterior Chamber Lens Implantation with Two Specifically Designed IOLs: Iris Claw Lens versus Sutureless Trans-Scleral Plugs Fixated Lens. *Journal of Clinical Medicine*, **10**, Article No. 2216. <https://doi.org/10.3390/jcm10102216>