Combined Surgery in the Treatment of Patients with Cataract and Primary Open-angle Glaucoma

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Abstract

Cataract and glaucoma are the two leading causes of blindness worldwide and frequently co-exist in the ageing population. No uniform recommendations can be proposed when the two conditions are associated. In the presence of a visually significant cataract and uncontrolled glaucoma, clinicians should consider performing combined cataract surgery and trabeculectomy. Numerous phacotrabeculectomy techniques have been proposed. However, in the absence of strong evidence in support of a specific technique, surgeons' preference and experience may dictate the choice. Unless contraindicated, mitomycin-C should be considered in all combined procedures. In addition, novel and minimally invasive glaucoma surgical procedures, such as ab interno trabeculotomy, have recently emerged and gained in popularity. In general, these procedures have shown the potential to be combined with phacoemulsification to further lower intraocular pressure (IOP) with relatively few post-operative complications. However, available data suggest that these techniques seem unlikely to be able to achieve a degree of IOP reduction comparable with that of trabeculectomy. Rigorous studies are necessary to better understand the long-term efficacy and safety profile of these novel procedures, when performed alone or in combination with cataract surgery.

Keywords

Cataract, intraocular pressure, primary open angle glaucoma, phacoemulsification, surgery, trabeculectomy

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Cataract and glaucoma are the two leading causes of blindness worldwide and frequently co-exist in the ageing population. Adequate management of these two conditions may require surgical intervention. In general, cataract extraction is necessary in case of visually significant lens opacity, while surgery for glaucoma is indicated when optimum medical therapy and/or laser surgery fails to sufficiently lower intraocular pressure (IOP) or a patient does not have access to or cannot comply with medical therapy.[1]

As a general rule, the management of glaucoma patients should be directed towards those treatments aimed at achieving an individualised target IOP safely and efficaciously. The presence of concomitant and visually significant cataracts can challenge the decision-making process, so that clinicians need to determine how cataract extraction would best fit the management of patients with glaucoma. In particular, when a combined surgical approach for cataract and glaucoma is desired, the timing of surgery and an accurate procedure selection are important aspects to consider. Phacotrabeculectomy techniques are not standardised and the way the procedure is performed is largely dictated by the surgeon's preference and experience.[1] Furthermore, novel and minimally invasive surgical approaches to lower IOP have been recently introduced and may be combined with phacoemulsification, representing a potential alternative to phacotrabeculectomy. This review is aimed at summarising current evidence on combined surgery in the treatment of patients with cataract and primary open angle glaucoma.

Effect of Cataract Surgery on Intraocular Pressure

In the presence of concomitant cataract and primary open angle glaucoma, one may argue that cataract extraction alone can help reduce IOP. However, this effect may be limited and transient. In fact, it has been shown that cataract surgery in non-glaucoma patients may transiently decrease IOP,[2–5] whereas it seems to have no effect on diurnal IOP fluctuations.[2] Several theories have been proposed to explain these findings, mostly involving anatomical or biochemical modifications induced by the surgical intervention.[6–8] As a result of cataract extraction, the anterior lens capsule is repositioned behind the Schlemm's canal. In this anatomical configuration, the tendons of the ciliary muscles may produce a traction on the ciliary body leading to a decreased aqueous humour production,[3] or to dilation of the trabecular meshwork and the Schlemm's canal.[9,10] Also, it has been hypothesised that low inflammation induced by phacoemulsification could decrease aqueous humour production or, alternatively, increase uveoscleral outflow via a prostaglandin-mediated mechanism. Finally, high flow dynamics and IOP spikes during phacoemulsification could expand the patency of the ocular drainage system facilitating the outflow.[7]

In glaucoma patients, on average, IOP is reduced after cataract surgery.[10–17] It should be noted that the amount of change in post-operative IOP may be a function of the IOP recorded at baseline, so that greater IOP reduction is expected in eyes with higher baseline

IOP. Thus, in glaucoma patients whose IOP is adequately controlled by medical treatment, the effect of cataract surgery on IOP reduction may be limited to 1–2 mmHg.[9,10] The decrease in IOP may be more pronounced at one-year post-cataract surgery and with time, IOP tends to return to baseline levels.[10–17] Interestingly, greater IOP reduction after phacoemulsification has been reported in eyes with pseudoexfoliation.[18–20]

Ultimately, clinicians ought to decide whether cataract surgery or trabeculectomy alone should be performed or, rather, cataract extraction should be combined with trabeculectomy or an alternative surgical technique to lower IOP. Several important factors may play a role in the clinical decision process. These factors include a careful assessment of the risk–benefit ratio associated with each surgical procedure, patients' preferences, patients' interindividual differences in the severity of glaucoma and their visual needs, cost–benefit analysis, as well as the experience and skill of the surgeon.[21] For example, patients with cataract and mild glaucomatous damage whose glaucoma appears stable and IOP is within the target range with well-tolerated medical therapy should represent the ideal candidates for cataract surgery alone, and a combined approach should be discouraged.

Combined Phacoemulsification and Trabeculectomy

Different considerations can be drawn in case of severe glaucoma with uncontrolled IOP despite maximum tolerated medical therapy. In these circumstances, patients should benefit from trabeculectomy. There is consensus that trabeculectomy provides 'better and more sustained IOP lowering than non-penetrating procedures' and it is considered the 'incisional procedure of choice in previously unoperated eyes'.[1] However, evidence has shown that trabeculectomy may be associated with an increased risk of cataract progression post-operatively.[22–25] Furthermore, subsequent cataract surgery may compromise the success of an earlier trabeculectomy.[26–28]

In the presence of a visually significant cataract and uncontrolled glaucoma, clinicians should consider performing combined cataract surgery and trabeculectomy. However, there appears to be no uniform recommendation for all cases. In a recent consensus report on glaucoma surgery, it was concluded that patients with primary open angle glaucoma who are undergoing cataract do not necessarily require combined surgery and that visual rehabilitation may take longer following a combined procedure.[29] Moreover, compared with trabeculectomy alone, combined cataract and glaucoma surgery is less successful for lowering IOP.

On the other hand, small incision cataract surgery and the intra-operative use of antimetabolites have rendered the choice of combining cataract surgery with trabeculectomy more appealing in recent years. A combined approach may avoid the occurrence of post-operative IOP spikes following cataract surgery in eyes with advanced glaucoma[30,31] and, if successful, it is possible to achieve long-term IOP control and vision improvement with a single operation.

There appears to be no standardised approach for phacotrabeculectomy. The procedure can be conducted using two main different strategies: one-site approach, that is, the same superior incision is used for both phacoemulsification and trabeculectomy; or two-site approach, that is, a clear corneal temporal incision is used for phacoemulsification and a superior scleral incision is used for trabeculectomy. It has been suggested that separating the incisions may reduce wound trauma, leading to less scarring to the scleral flap and conjunctiva, and better filtration.[32] At the same time, the two-site approach generally requires greater intra-operative time and may be associated with lower endothelial cell count.[33,34] However, despite intense research on the subject, there is little evidence that a two-site approach for combined surgery might achieve a better IOP control.[32,33,35–43]

There appears to be no difference in terms of IOP lowering effect whether phacotrabeculectomy is performed using a fornix-based or a limbus-based conjunctival flap,[38,44–48] or whether the procedure is performed with or without peripheral iridectomy.[49–51] However, stronger evidence supports the use of mitomycin-C to achieve greater IOP reduction in combined procedures.[40,52–55]

In summary, in the absence of strong evidence in support of a specific technique for phacotrabeculectomy, surgeons' preference and experience will dictate the choice. Unless contraindicated, mitomycin-C should be considered in all combined procedures.

Combined Phacoemulsification and Glaucoma Drainage Implants

Glaucoma drainage devices (GDD), also known as tube shunts or setons, are typically used when trabeculectomy fails to control IOP or trabeculectomy is deemed unlikely to be successful. However, a recent report indicates that GDD use and indications for the treatment of glaucoma are increasing.[56]

Results from three retrospective studies that evaluated phacoemulsification combined with Ahmed valve or Baerveldt implant suggest that GDD combined with cataract surgery may be safe and effective for IOP control in primary open angle glaucoma.[57–59] In a study by Molteno et al. cataract surgery (phacoemulsification or extracapsular cataract extraction) was combined with Molteno implant or trabeculectomy (one- or two-sites).[60] The authors reported better IOP control in the group treated with combined cataract surgery and Molteno implant. Further prospective, randomised trials aimed at comparing the combined treatment phacoemulsification-GDD implant with phacotrabeculectomy are necessary to confirm these findings.

Novel Glaucoma Surgical Procedures

New, minimally invasive surgical techniques with the potential to significantly lower IOP have recently emerged and gained in popularity during the past few years. Among these, Fugo blade™ (Medisurg, Norristown, PA) for transciliary filtration or goniotomy, Ex-PRESS™ mini glaucoma shunt (Alcon, Hunenberg, Switzerland), SOLX® Gold Shunt (SOLX, Boston, MA), excimer laser trabeculotomy (AIDA, Gluatec AG, Nurnberg, Germany), canaloplasty (iScience Interventional, Menlo Park, CA), ab interno trabeculotomy (Trabectome™, NeoMedix, Tustin, CA) and trabecular meshwork bypass stent (iStent™, Glaukos Corporation, Laguna Hills, CA) have received US Food and Drug Administration clearance or are currently under Phase III trial.[61,62]

Francis et al. recently described these novel procedures and their intended mechanism of action in detail.[61] For example, Fugo blade goniotomy, excimer laser trabeculotomy, Trabectome and iStent are designed to improve aqueous humour outflow bypassing the juxtacanalicular connective tissue of the trabecular meshwork which is thought to be the site of the main resistance to outflow,[63] thus re-routing the aqueous from the anterior chamber directly into the Schlemm's canal.

Theoretically, the benefits from these ab interno approaches come from the spare of the conjunctiva and the absence of an external bleb that, in turn, eliminate the risk of bleb-related complications, and the possibility to combine the procedure with phacoemulsification. It is important to emphasise that ab interno procedures leave the conjunctiva intact, thus further incisional surgery is not precluded. It is well-known that the success rate of glaucoma filtering surgery is decreased in case of previous cataract operation involving the conjunctiva.[64]

Trabectome surgery consists in the electrosurgical ablation of a portion, usually 90–120 degrees, of the trabecular meshwork and the inner wall of the Schlemm's canal. The procedure has shown the potential to be combined with phacoemulsification to further lower IOP with relatively few post-operative complications. In a preliminary study, at 12 months post-operatively, the mean IOP was approximately 4 mmHg lower compared with baseline.[65] However, it should be noted that this investigation is characterised by a substantial drop-out rate: the number of study eyes decreased from 304 at baseline to 34 at 12-month follow-up.

Similarly, iStent to be implanted during cataract surgery has shown some efficacy in decreasing IOP, with reduction in the range of 3 mmHg at 15 months post-operatively.[66] In a recent prospective, randomised, controlled trial of patients with open angle glaucoma and cataract who underwent phacoemulsification and iStent implantation, IOP decreased 8.4 ± 3.6 mmHg at 12 months post-operatively. Considering pre-washout IOP values, the estimated reduction was 1.5 ± 3.0 mmHg. However, the control group had a similar IOP reduction.[67]

Ab externo glaucoma procedures that have been combined with cataract surgery include Ex-PRESS mini shunt[68–71] and canaloplasty.[72] Both techniques may be effective in lowering IOP. However, Ex-PRESS mini shunt alone had a better IOP reduction than when combined with phacoemulsification at three years post-operatively. This finding should be interpreted with caution since the two groups had a significantly different baseline IOP, with higher values in the group treated with Ex-PRESS implant alone (27.9 ± 10.7 versus 20.9 ± 7.4 mmHg).[69] Alternative procedures to be performed during cataract surgery, such as endocyclophotocoagulation, have also been proposed.[73,74]

In summary, available data suggest that these techniques seem unlikely to be able to achieve a degree of IOP reduction comparable with that of trabeculectomy. When reviewing the literature, limitations frequently encountered in the above referenced trials are the retrospective design, lack of randomisation, absence of a control arm and unmasked design. In addition, in several cases, limited sample size and follow-up represent important additional limitations to the generalisability of the results. Further rigorous studies are necessary to determine the efficacy and safety of these techniques, particularly when combined with cataract surgery. Recently, the World Glaucoma Association has developed detailed guidelines on design and reporting of glaucoma surgical trials with the hope to improve the level of evidence and facilitate the decision making process in glaucoma surgery.[75]

Conclusion

No uniform recommendations can be proposed for all cases of primary open angle glaucoma associated with visually significant cataract. It is important that clinicians evaluate multiple factors before taking important surgical decisions. These factors include patients' demographic and clinical features, such as age and life expectancy, disease severity and ability to tolerate medications, along with the desired IOP control to be achieved after surgery. Although numerous studies have been conducted on the subject, no strict criteria for IOP or visual acuity levels at which combined surgery should always be preferred could be established.

In eyes with open angle glaucoma, cataract surgery alone may be of limited clinical benefit in lowering IOP. In the presence of a visually significant cataract and uncontrolled glaucoma, clinicians should consider performing combined cataract surgery and trabeculectomy. The intra-operative use of mitomycin-C should be considered in all combined procedures, whereas there is little evidence that a two-site should be preferred versus a one-site approach to achieve a better long-term IOP control.

Novel and minimally invasive surgical techniques for glaucoma have the potential to further lower IOP when combined with phacoemulsification, as suggested by recent studies. However, trabeculectomy may still provide better and more sustained IOP lowering effect.

Rigorous studies with longer follow-up and larger sample size are warranted to better understand the long-term efficacy and safety profile of these novel procedures, when performed alone or in combination with cataract surgery. ■

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