# Endoscopic cyclophotocoagulation and Kahook Dual Blade trabeculotomy in combination with phacoemulsification

Convenient to perform alongside cataract surgery and relatively safe, minimally invasive glaucoma surgeries (MIGS) are growing in popularity. Few studies have examined the effect and safety of performing combined MIGS.

We examined the outcomes of combining two distinct MIGS: endoscopic cyclophotocoagulation (ECP) and ab interno trabeculotomy with Kahook Dual Blade (KDB; New World Medical, Rancho Cucamonga, Calif), along with phacoemulsification cataract extraction with intraocular lens placement (PEIOL). ECP is a cyclodestructive procedure with the goal of treating the ciliary processes to disable the aqueous-producing ciliary epithelium. ECP tends to be more durable in older patients. Younger patients tend to require re-treatment as either the epithelium returns or the residual epithelium increases function. KDB treatment aims to remove trabecular meshwork in a more complete fashion than alternative forms of ab interno trabeculotomy. The suspected location of greatest resistance to outflow, the juxtacanalicular meshwork, is included in this treatment. By decreasing aqueous production with ECP and increasing aqueous outflow with KDB, we hypothesize intraocular pressure (IOP) may decrease, in an additive fashion, more than with either procedure alone while maintaining a low side effect profile.

All eyes in this case series were diagnosed with mild to moderate open-angle glaucoma (OAG) and a visually significant cataract. All eyes underwent ECP, KDB, and PEIOL. PEIOL was performed first, then ECP over approximately 270 degrees of the ciliary processes, with sparing of the temporal quadrants, and KDB for approximately 90 degrees of the nasal quadrant. Data were collected and de-identified for analysis. Data included visual acuity (VA), IOP, number of medications, and complications. Data were recorded at the preoperative visit and then at 1 day, 1 week, and 1, 3, 6, and 12 months postoperatively.

Averaged data at each follow-up time point were compared to preoperative data using a paired $t$ test. The limit of statistical significance was set at $p < 0.05$.

Ten eyes from 7 patients were examined in this series. The average patient age was 68 ± 7 years, and the distribution of males and females was equal (see Table 1). Patients were Caucasian (70%), Asian (20%), and African American (10%). Only 1 eye had received prior laser treatment with selective laser trabeculoplasty. Mean historical maximum IOP was 25.3 ± 3.7 mm Hg. At the preoperative visit, mean IOP was found to be 18.6 ± 3.9 mm Hg, and patients were on a mean of 2.1 ± 1.4 IOP medications, which included varying combinations of latanoprost, timolol, dorzolamide, and brimonidine. Preoperative Humphrey visual field mean deviation was −4.38 ± 4.85 dB. No eye lost vision as a result of surgery, and all patients had a best corrected VA of 20/20 or better at 12 months.

Mean IOP from postoperative month 3 to month 12 ranged from 13.9 to 16.0 mm Hg (see Table 2). Absolute mean reduction in IOP by 12 months was 3.9 ± 4.2 mm Hg ($p = 0.017$), or an 18% ± 18.5% ($p = 0.013$) decrease. The number of IOP medications decreased to 1.0 ± 1.2 by postoperative month 3 and was 0.8 ± 0.9 by postoperative month 12. Absolute reduction in medications was 1.3 ± 1.1 ($p = 0.004$), or a 68.5% ± 34.9% decrease ($p < 0.001$).

At month 12, all eyes were either an IOP or medication reduction success. A ≥20% reduction in IOP was considered a successful IOP outcome, with 40% of eyes achieving this result at month 12. A successful medication outcome, deemed a ≥1 medication reduction, was achieved in 90% of eyes at month 12. The one eye that did not achieve this result was on no medications previously, and IOP in this eye was reduced by greater than 20%. All patients completed 12 months of follow-up, and no patients required additional glaucoma intervention.

**Table 1—Data**

| | | | | Preop | | POM3 | | POM6 | | POM12 | | IOP | | Med | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | Sex | Race | Tm | IOP | Meds | IOP | Meds | IOP | Meds | IOP | Meds | Δ %* | Δ #† | Δ # %‡ | Δ #§ |
| 78 | F | A | 22 | 20 | 3 | 15 | 1 | 15 | 1 | 16 | 1 | −20% | −4 | −67% | −2 |
| 78 | F | A | 22 | 20 | 3 | 16 | 1 | 15 | 1 | 16 | 1 | −20% | −4 | −67% | −2 |
| 65 | F | C | 22 | 14 | 4 | 16 | 1 | 14 | 1 | 14 | 1 | 0% | 0 | −75% | −3 |
| 70 | M | C | 22 | 12 | 2 | 11 | 0 | 9 | 0 | 13 | 0 | 8% | 1 | −100% | −2 |
| 57 | M | AA | 29 | 24 | 4 | 23 | 4 | 12 | 3 | 11 | 3 | −54% | −13 | −25% | −1 |
| 71 | M | C | 26 | 16 | 1 | 15 | 1 | 16 | 1 | 15 | 0 | −6% | −1 | −100% | −1 |
| 63 | M | C | 31 | 23 | 2 | 16 | 0 | 20 | 0 | 15 | 1 | −35% | −8 | −50% | −1 |
| 63 | M | C | 27 | 20 | 0 | 18 | 2 | 11 | 1 | 14 | 1 | −30% | −6 | N/A | 1 |
| 65 | F | C | 30 | 21 | 1 | 16 | 0 | 16 | 0 | 20 | 0 | −5% | −1 | −100% | −1 |
| 65 | F | C | 22 | 16 | 1 | 14 | 0 | 11 | 0 | 13 | 0 | −19% | −3 | −100% | −1 |

Preop, preoperative; POM, Postoperative Month; IOP, intraocular pressure; Med, Medications; Tm, Maximum recorded IOP; A, Asian; C, Caucasian; AA, African American

*Δ % = Percent IOP reduction

†Δ # = Change in IOP mmHg

‡Δ # % = Percent IOP reduction

§Δ # = Change in number of IOP medications used

**Table 2—Intraocular pressure and medications over time (mean ± standard deviation)**

| | Mean IOP (mm Hg) | Absolute IOP reduction (mm Hg) | Percent IOP reduction (%) | Medications (n) | Absolute medication reduction (n) |
|---|---|---|---|---|---|
| Preoperative | 18.6 ± 3.9 | — | — | 2.1 ± 1.4 | — |
| 3 months | 16.0 ± 3.1 | −2.6 ± 2.6 ($p = 0.012$) | −12.6 ± 13.0 ($p = 0.013$) | 1.0 ± 1.2 | −1.1 ± 1.4 ($p = 0.040$) |
| 6 months | 13.9 ± 3.2 | −4.7 ± 3.7 ($p = 0.003$) | −23.8 ± 16.5 ($p = 0.001$) | 0.8. ± 0.9 | −1.3 ± 1.2 ($p = 0.017$) |
| 12 months | 14.7 ± 2.4 | −3.9 ± 4.2 ($p = 0.017$) | −18.0 ± 18.5 ($p = 0.013$) | 0.8 ± 0.9 | −1.3 ± 1.1 ($p = 0.004$) |

IOP, intraocular pressure

Transient complications arose in 2 eyes. A visually significant microhyphema was found in 1 eye in postoperative week 1 and spontaneously resolved. A second eye experienced an IOP spike on postoperative day 1 to 48 mm Hg, which normalized with IOP medication. The same eye was found to have cystoid macular edema at month 1, which resolved with anti-inflammatory treatment by month 3.

Aliendres et al. are working on a similar study of PEIOL, ECP, and KDB of 49 eyes.[1] Their data are unpublished, but their abstract reports a 6-month IOP decrease from a baseline of 16.96 ± 3.66 mm Hg to 11.44 ± 2.15 mm Hg at postoperative month 6. This represents a 32.5% IOP decrease and an average IOP medication decrease of 1.2, representing a 60% change. These results were favourable compared to ours in terms of IOP reduction and similar in terms of decrease in medication use.

Two studies on ECP combined with PEIOL—one by Francis et al.[2] and one by Siegel et al.[2] —are comparable. Francis et al. found a 12% IOP reduction and 73% reduction in medications at 12 months.[2] Siegel et al. found a 15% IOP reduction and 85% reduction in medications at 12 months.[3] Preoperative IOP measurements in both studies were comparable to ours at 18.1 ± 3.0 mm Hg and 17.2 ± 4.8 mm Hg, respectively. We can reasonably conclude that PEIOL with ECP and KDB is at least as efficacious as PEIOL and ECP out to 12 months.

Studies on KDB vary, making comparison difficult. Dorairaj et al. combined KDB with PEIOL and found an average 26.2% IOP reduction and 50% reduction in medications at 12 months.[4] Berdahl et al. examined KDB alone and noted an impressive 36.2% IOP reduction and 40% reduction in medications at 6 months.[5] KDB with PEIOL resulted in 57.7% and 63.5% of eyes achieving a successful IOP and medication outcome, respectively.[4] KDB alone resulted in 69.8% and 67.9% of eyes achieving a successful IOP and medication outcome, respectively.[5] Our combination decreased IOP less but led to a greater reduction in medications. Our successful outcome measures at 6 months were similar to those of Berdahl et al., with a slightly higher IOP at 12 months.

One might assume that adding KDB to PEIOL ECP, or ECP to PEIOL KDB, offers little additional benefit. However, there are many confounding factors. First, it is possible that our small sample size is hiding the effect of the additional procedure. Second, ECP treatment can vary greatly in treatment extent and aggressiveness of application even when applied by a single surgeon in a single day. Third, adding KDB to ECP PEIOL may increase the durability of the IOP-lowering effect. This would require longer study follow-up than the 12-month postoperative time interval of this study.

Comparison is also difficult due to missing variables, potential bias, and methodologic differences. Our demographic data were similar to Berdahl et al. Demographic data from Dorairaj et al. were sparse. Both studies performed a subgroup analysis showing IOP reduction ranged greatly between lower and higher preoperative IOP groups.[4,5] Also, both of these studies received industry funding. The decision to add or remove an IOP medication is not a prescribed function. One study might have valued a lower IOP more than decreased medication burden. It is likely that this investigator would have a more impressive IOP drop but less impressive decrease in medication use.

Overall, our case series demonstrates that the combination of ECP and KDB with PEIOL is comparatively safe and offers a decrease in IOP medication use at least as great as either procedure alone with PEIOL. Our small sample size was our greatest limitation in detecting subtleties in efficacy and did not allow for subgroup analyses. Furthermore, although KDB is performed on a different anatomic structure than ECP, we performed the KDB in the same quadrant as ECP. It is possible that performing the KDB in a quadrant untreated by ECP would change results given the anatomic changes caused by the procedures. Future directions include expansion of the study size, further subgroup analysis by preoperative IOP, and ultimately randomized control studies.

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## Footnotes and Disclosure

The authors have no proprietary or commercial interest in any materials discussed in this article.

# Superior oblique myositis following targeted therapy for papillary thyroid carcinoma


Papillary carcinoma of the thyroid gland (PCTG) constitutes 80%–85% of thyroid cancers globally. Despite early lymphatic invasion, PCTG has a relatively indolent course and rarely metastasizes outside of the neck.[1] Metastasis to the brain from PCTG is even more uncommon and usually occurs in the context of widely disseminated disease. While the mainstay of treatment for intracranial metastasis from PCTG includes surgical excision and radiotherapy, recent advances into our understanding of the molecular pathways governing PCTG have facilitated development of novel targeted chemotherapeutics. We present a case of superior oblique myositis that was presumed secondary to treatment of widely metastatic PCTG with dabrafenib and trametinib therapy. To our knowledge this is the first such case in the English language ophthalmic literature.

## Case

A 61-year-old man presented with subacute, progressive, right-sided peripheral vision loss preceded by a month of headaches, 2 episodes of right-sided scintillating scotomas, and a single episode of transient confusion. Past medical history was significant for PCTG treated with total thyroidectomy, bilateral paratracheal, and lateral compartment neck dissection, followed by radioactive iodine therapy. Initial evaluation revealed 20/20 visual acuity in both eyes (OU) and a right homonymous hemianopsia. Computed tomography (CT) scan of the brain showed vasogenic edema and a mass in the left parieto-occipital lobe. Magnetic resonance imaging (MRI) showed multifocal brain metastasis, including left parietal-occipital lesion. CT scan of the chest and abdomen revealed metastatic involvement of the lungs, hilar and mediastinal lymph nodes, kidneys, and liver. The patient was treated with oral prednisone and levetiracetam. After surgical resection the patient was treated with 10 rounds of whole brain radiotherapy followed by a single round of stereotactic radiosurgery to the residual left parietal-occipital lesion. BRAF V600E testing confirmed the mutation, and the patient was treated with 300 mg/day of dabrafenib and 2 mg/day of trametinib. The trametinib dosage was subsequently reduced to 150 mg/day owing to nausea and vomiting.

Eight months after his initial presentation, the patient endured 3 weeks of right frontal headache and new binocular vertical diplopia. On examination, visual acuity had decreased to 20/50 in the left eye (OS). There was a left hypertropia of 15 prism diopters OS. Cerebrospinal fluid analysis was unremarkable with normal glucose, protein, leukocyte count, and negative malignant cells on cytology. Repeat CT scan of the head showed stable intracranial lesions. MRI of the brain and orbits revealed enhancement of the left superior oblique muscle and surrounding soft tissue (Figs. 1A and 1B). Owing to concerns for a superior oblique myositis secondary to dabrafenib and trametinib therapy, the patient was treated with a reduced dosage of these medications and initiated on a 30-day oral prednisone taper, which resolved the symptoms.

At a subsequent 2-month follow-up, the patient reported interval resolution of his right frontal headache and vertical diplopia. Unfortunately, the vertical diplopia recurred 1 week before the follow-up examination, coinciding with weaning of his prednisone therapy. His prednisone was increased and reweaned without recurrence of symptoms. Repeat MRI of the brain and orbits revealed decreased enhancement of the left distal superior oblique muscle in comparison with prior imaging (Fig. 1C).

## Discussion

Thyroid cancer accounts for 1% of malignancies globally. PCTG is classified as a form of differentiated cancer that arises from thyroid follicular cells. The standard therapeutic approach to PCTG involves surgical resection followed by radioactive iodine ablation. Owing to the indolent course of PCTG and a high response rate to treatment, the prognosis for PCTG is excellent, with a 95% 5-year survival rate. Unfortunately, between 4%–15% of PCTGs remain resistant to standard treatment and metastasize to distant sites.[1] These aggressive PCTGs have a comparatively poor prognosis, necessitating the development of effective salvage therapies. Several novel therapeutics have been recently approved for treatment of aggressive PCTGs and are generally classified into 2 categories: small molecule-kinase inhibitors and immunotherapy.[2] Small-molecule kinase inhibitors are directed against intracellular signalling pathways that control cellular survival, proliferation, and differentiation, whereas cancer immunotherapies enhance the body's immune response against malignant cells.