Additive effect of unoprostone and latanoprost in patients with elevated intraocular pressure

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Methods: 32 patients with POAG or OHT were randomised to receive either latanoprost once daily or unoprostone twice daily for 4 weeks. After 4 weeks, all patients received both latanoprost and unoprostone for another 4 weeks. The IOP was measured at 9 am and 5 pm on the baseline, day 28, and day 56 visits, and at 9 am on day 14 and day 42 visits. The medications were given to the patients in an open label fashion. The observer was masked to the treatment given. The mean of the measurements was calculated. Safety parameters were also recorded. The additive effect of the medications was assessed by the reduction in intraocular pressure (IOP) when both medications were used, compared with when one medication was used.

Results: 28 patients completed both treatment periods and had IOP data available for evaluation. After 1 month of treatment, latanoprost significantly reduced IOP (mean by 6.1 [SEM 0.8] mm Hg [p<0.001] and unoprostone by 4.9 [1.0] mm Hg [p<0.001]) from the baseline of 24.4 [0.6] mm Hg and 24.4 [1.1] mm Hg respectively (p = 0.18). When latanoprost once daily was given to patients treated with unoprostone, there was additional IOP lowering of 1.9 [0.6] mm Hg (p = 0.012). However, adding unoprostone to those being treated with latanoprost produced an IOP change of +0.4 (0.5) mm Hg (p = 0.42). Ocular symptoms and findings were mild and equally distributed between treatment groups, and after combined therapy. Hyperaemia and ocular irritation were the most frequently reported events. Over a third of patients experienced ocular irritation with the combination of medications.

Conclusions: Latanoprost once daily causes additional IOP lowering in eyes which were being treated with unoprostone twice a day. However, there was no additional IOP lowering when unoprostone was added to eyes which were being treated with latanoprost. Both drugs were well tolerated together with few ocular adverse events.

Therapeutic regimens for glaucoma have changed dramatically in the past few years. Never glaucoma therapies such as the prostaglandin analogues, latanoprost and unoprostone, have few side effects and convenient dose schedules. Latanoprost, a prostaglandin Fα analogue, has proved to be an effective ocular hypotensive drug. Its main mechanism for reducing intraocular pressure (IOP) is an increase in the uveoscleral outflow. In long term studies, latanoprost 0.005% applied once daily reduced IOP as effectively as the β adrenergic receptor antagonist timolol in patients with primary open angle glaucoma (POAG) or ocular hypertension (OHT). Unoprostone isopropylate is a docosanoid derived from a metabolite of a primary prostaglandin, 13,14-dihydro-15-keto prostaglandin. It was found to have a significant ocular hypotensive effect, and was as effective as timolol in reducing IOP in POAG. It is thought to act by increasing uveoscleral outflow, similar to latanoprost. However, a study by Taniguchi et al suggested that unoprostone may increase conventional trabecular outflow.

There is no published literature on the additive effect of latanoprost with unoprostone for treatment of primary open angle glaucoma and ocular hypertension. In view of the possibility that they may have differing mechanisms of action, it would be interesting to know if the two drugs exert greater IOP lowering effect when used together. This is especially so in patients who are intolerant or have contraindications to β blocker therapy and a prostaglandin analogue may need to be used. It would also be useful to determine the side effects in patients based on the combined response to these drugs. This study was thus designed to assess the additive ocular hypotensive effect and side effects of using unoprostone and latanoprost together in patients with elevated IOP.

MATERIALS AND METHODS
This two centre study was prospectively carried out at the Singapore National Eye Centre and the National University Hospital, Singapore. After obtaining approval from the ethics committees of each centre and by the Ministry of Health of Singapore, a signed informed consent was obtained from all patients before study enrolment. The study was performed according to the Declaration of Helsinki and the Singapore guidelines on good clinical practice.

Patients 21 years of age or older with primary open angle glaucoma or ocular hypertension were eligible. All patients recruited had IOP >21 mm Hg at the prestudy visit and were previously untreated. POAG was defined as glaucomatous optic neuropathy with a compatible visual field defect and open angles on gonioscopy, while OHT patients had normal optic discs and visual fields and open angles. Glaucomatous optic neuropathy was defined as a cup:disc ratio of >0.6, or the presence of notch ing. A threshold examination of the central 24° of visual field (24-2 program) showing a glaucoma hemifield test (GHT) “outside normal limits,” and a cluster of three contiguous points on the pattern deviation plot depressed at p<5% level (compared with age matched normal subjects) not crossing the horizontal meridian, was considered compatible with glaucoma. Test reliability was determined by the instrument’s algorithm.
Patients requiring bilateral treatment had to fulfill all eligibility criteria for both eyes to be included. However, if only one eye fulfilled the inclusion criteria, that eye was included as the study eye and the fellow eye could be treated with the allocated study therapy provided that no exclusion criteria were met.

Exclusion criteria were gonioscopic appearance of angle closure, secondary glaucoma such as uveitis, neovascular glaucoma or post-trauma, previous intraocular surgery, previous trauma to the eye with damage of the anterior chamber angle, the fellow eye on treatment with another IOP reducing drug, previous treatment with glaucoma therapy, previous corneal infection or corneal abnormalities, uveitis or dry eyes, current use of contact lenses, oral drugs known to affect the IOP, and known allergy to benzalkonium chloride. Also, a history of cerebrovascular, hepatic, or metabolic disease (except diabetes mellitus) was considered a reason for exclusion. Currently, pregnant or nursing women, or women considering pregnancy were also excluded, as well as patients with a history of non-compliance or patients who participated in another therapeutic drug study within 1 month.

There were two treatment periods of 4 weeks each. At the prestudy visit, medical and ocular history was taken. Visual acuity and refraction, slit lamp examination, ophthalmoscopy, and a measurement of the IOP were performed. Gonioscopy and perimetry were also carried out. Patients were included after these eligibility assessments.

On the baseline day, the patients were randomised (by block randomisation) to two parallel study groups: one group was assigned to treatment with latanoprost 0.005% in the evening and the other group received unoprostone 0.12% twice daily, for a duration of 4 weeks. After 4 weeks, all patients were given 0.12% unoprostone twice daily (in the morning and evening) and latanoprost 0.005% in the evening, for another 4 weeks.

All types of medication were dispensed open label as the commercially available preparation, latanoprost (Xalatan, Pharmacia Corporation, Uppsala, Sweden) and unoprostone (Rescula, Ciba Vision Ophthalmics, Bulach, Switzerland). Patients were instructed to instil unoprostone at approximately 8 am and 8 pm each day and latanoprost at 8 pm. When on both medications, the evening unoprostone and latanoprost doses were administered 10 minutes apart. On visit days to the clinic (days 14, 28, 42, and 56), those on unoprostone administered the eye drops in the mornings at 7 am before the clinic visit. Patients were informed to adhere strictly to the timing of the drops and the time of administration of drops was recorded.

During each study period there were three scheduled visits: at day 0, day 14, and day 28. The IOP was measured at 9 am and 5 pm on the baseline, day 28, and day 56 visits, and at 9 am on day 14 and day 42 visits. The IOP was measured with a Goldmann applanation tonometer. Three measurements were performed in each eye, and the mean of the three measurements was used in the statistical analyses. The observer was masked to the treatment given. Best corrected Snellen visual acuity and refractive error, systemic blood pressure, and pulse rate were determined at each visit, and a slit lamp examination was performed. The presence of cells and flare in the anterior chamber was investigated during slit lamp examination. Flare was graded as none, moderate, or severe, and cells present in a slit of 2 mm width were graded as none (1–2 cells), mild (3–5 cells), moderate (6–20 cells), or severe (≥20 cells).

Adverse events were monitored carefully throughout the study. An adverse event was defined as any undesirable event occurring in a subject regardless of whether it was considered related to the drug being investigated. A serious adverse event was defined as an event that was potentially fatal, life threatening, permanently disabling, requiring hospitalisation, or requiring intervention to prevent permanent impairment or damage.

Statistical evaluation
For each patient, the IOP value was calculated at baseline and day 28 of each period as the mean of all measurements made on the study eye(s) on that day (mean diurnal IOP). If the patient had only one study eye, the average was based on the measurements made in that eye only. For patients with bilateral disease, data from one eye chosen at random in each individual were selected for analysis. In the event that the patient was missing one or more measurements, the average was based on the non-missing measurements.

The primary objective of the study was to test if latanoprost was additive to unoprostone, and vice versa. The null hypothesis was defined as IOP reduction on day 28 (monotherapy) being equal to the IOP reduction on day 36 (combined therapy), in both cases compared with the IOP on day 0. The alternative hypothesis was that the combination therapy further reduced IOP by 3 mm Hg compared with treatment with only one drug. The further reduction was presumed to represent the additive effect of the second drug since the effect of the first drug is assumed to be stable after 28 days of treatment.

It is anticipated that the between treatment groups SD is 3 mm Hg. The trial size of 32 will be sufficient to detect a difference in IOP between day 42 and day 28 of 3.0 mm Hg, with a two sided test size of 5% and power 90%.

All statistical tests were conducted at the 5% level using SPSS software version 8.0 (Statistical Package for Social Sciences, Chicago, IL, USA).

RESULTS
Of the 32 patients randomised to the study, 15 were randomised to start with latanoprost and 17 started with unoprostone. Two patients starting on unoprostone withdrew after day 14 because of side effects.

At day 28, the remaining 30 patients had the other medication added and were on both medications. Two additional patients withdrew before the day 42 visit. Both subjects (one on unoprostone and the other on latanoprost) could not tolerate the side effects.

Unless otherwise stated, the following analyses will take into account 15 subjects on day 28 and 14 subjects on day 56 in each of the groups.

Table 1 refers to the baseline demographic characteristics. There were no significant differences between the two groups with respect to sex, race, and age. As for other factors such as laterality of eyes involved, type of glaucoma, medical history, use of concomitant treatment, ocular symptoms and findings, and vital signs at the prestudy visit, the two treatment groups were comparable.

Change in intraocular pressure during the study periods
Table 2 summarises the change in IOP in the two groups in each study period.

At the end of period 1 (day 28), the mean decrease in IOP was 6.1 (0.8) mm Hg (p<0.0001) for latanoprost treated patients, and 4.9 (1.0) mm Hg (p=0.0001) for unoprostone treated patients. The mean difference in IOP drop between the two groups was 1.2 (1.3) mm Hg in favour of latanoprost (p=0.35). Every patient had IOP lowering with the medications in this study period (100% response).

At the end of period 2 (day 56), mean decrease in IOP in the latanoprost-unoprostone group was +0.4 (0.5) mm Hg (p=0.42). However, for the unoprostone-latanoprost group, the mean change in IOP during period 2 was 1.9 (0.6) mm Hg (p=0.012). This difference in IOP change of 2.3 (0.8) mm Hg between the two groups in period 2 was significant (p=0.009). Adjusting for day 28 IOP this difference increases to 2.5 (0.9) (p = 0.009, 95% CI 0.7 to 4.3).
Only 43% of patients on latanoprost had IOP lowering when unoprostone was added. In contrast, 86% of patients on unoprostone experienced lowering of IOP when latanoprost was added to unoprostone treatment.

**Adverse events**
The adverse events experienced by the subjects by period are summarised in Table 3.

There were a few patients with systemic adverse events during the study. In the first period, one patient experienced palpitations while on unoprostone, stopped the medication on day 14, and withdrew from the study. During the second study period, there was one patient who had body itch after having latanoprost added to her treatment. Another subject experienced fatigue and giddiness, but neither complaint was of sufficient severity to stop treatment. In all cases, the systemic symptoms resolved after cessation of treatment.

There were three subjects who withdrew from the study because of ocular side effects. One subject stopped the trial medication (in this case unoprostone) on day 14, as she developed eye redness and pain after applying the drops. This resolved on stopping the medication. The other two subjects withdrew on day 42 as they experienced intolerable eye irritation after having the second medication added.

Ocular adverse effects were generally mild in nature and similar in the two groups. The commonest adverse events were ocular irritation and redness. Over a third of patients experienced ocular irritation with the combination of medications. There was only one subject who had mild anterior chamber inflammation, while on unoprostone only. Interestingly, there was no case of ocular inflammation found in the second study period when subjects were on two medications.

**DISCUSSION**
Many glaucoma patients are treated with more than one ocular hypotensive medication. This is especially so after the introduction of newer medications with fewer side effects and convenient dose schedules, such as the prostaglandin analogues. Determination of additive effects on IOP of such glaucoma medications will help define optimum treatment regimens for patients. It has been previously reported that latanoprost has an additive IOP lowering effect when used with timolol, pilocarpine, dipivefrin, dorzolamide, acetazolamide, and the combination of timolol and dorzolamide. The question of whether two of the new prostaglandin analogues, latanoprost and unoprostone, are additive when used together is interesting. Theoretically, this is possible if the two medications have differing mechanisms of action on aqueous outflow.

Our study found that when latanoprost once daily was added to patients being treated with unoprostone twice daily,
there was an additional IOP lowering of 1.9 (0.6) mm Hg (p=0.012) indicating that there was additive effect. However, adding unoprostone to those being treated with latanoprost produced a negligible effect on IOP (change of +0.4 (0.5) mm Hg, p=0.42). The findings are in agreement with those of Stewart and colleagues who also found no significant reduction in the mean diurnal curve of the IOP compared with placebo when adding unoprostone to latanoprost, although there was some variance in response that appeared to be based on the baseline IOP of latanoprost treated eyes.

Several reasons may account for the difference in effect found in our study. A plausible explanation is that unoprostone is less effective in reducing IOP at lower IOP levels. This was the case at the beginning of study period 2 when the mean baseline IOP of latanoprost-unoprostone treated patients was 17.8 (0.4) mm Hg, which was in the physiological range. A previous report found that unoprostone reduces IOP by about 10% in normal tension glaucoma. Latanoprost, on the other hand, has been previously shown to be effective at so-called “low” IOPs in patients with this form of glaucoma, and produces an IOP reduction of approximately 20%. In this study, the mean baseline IOP of unoprostone-latanoprost patients at the start of study period 2 was 19.6 (0.9) mm Hg. Although this was also within the physiological range, it was within the efficacy range of latanoprost. Another possible reason to explain the lack of additive effect when unoprostone was added to latanoprost is that there were many patients who did not show IOP lowering with unoprostone in the second study period. Only 43% of patients on latanoprost had IOP lowering when unoprostone was added. In contrast, 86% of patients on unoprostone experienced lowering of IOP when latanoprost was added to unoprostone treatment. In the first study period, all patients (100%) in both groups had IOP lowering with the study medications. It is possible that both latanoprost and unoprostone are competing for the same prostaglandin receptor sites, and latanoprost is more highly competitive or more potent than unoprostone. Thus, when latanoprost is added to unoprostone therapy, there is additional effect, but not vice versa.

Finally, the additional IOP lowering attributed to the addition of latanoprost may actually be due to the delayed response of unoprostone. This is possible if unoprostone had not achieved maximum IOP lowering at the end of 4 weeks of treatment (the first study period), and it only reached its maximum response later. The time required for maximum IOP lowering effect for unoprostone is not known. However, a previous study has shown that after 2 weeks of treatment, latanoprost had almost reached maximum response, compared with 1 and 6 months of treatment. Thus, 1 month of treatment should have been sufficient to produce a maximum response in both study groups.

The other significant finding in this study is that latanoprost and unoprostone can be used together without clinically unacceptable systemic or ocular side effects. Overall, both drugs were well tolerated individually and together. The side effects found in the second study period when the two drugs were used together were infrequent and generally mild in nature. The most common complaint was ocular irritation (10 subjects) but only two subjects found it serious enough to stop treatment. There were a few cases of conjunctival hyperaemia. Because prostaglandins are known to be released in the inflammatory response, cells and flare in the anterior chamber were regularly monitored during both study periods. However, there was no case of uveitis found during combined therapy. The only systemic adverse effects found during combined therapy were vague complaints of giddiness and fatigue in one case and body itch in another. We were not able to be sure that these systemic adverse events were caused by the medications, as the patients were not rechallenged with the same eye drops after completion of the study.

The main limitation of this study was that it was single masked to the observer only. A placebo was also not used for the morning dose in the latanoprost group. Accordingly, the side effects found when the second medication was added must be interpreted with caution because of the open label dosing and lack of placebo in the trial.

In conclusion, this study has shown that latanoprost once daily causes additional IOP lowering in eyes which were being treated with unoprostone twice a day. However, there was no additional IOP lowering when unoprostone was added to eyes which were being treated with latanoprost. Both drugs were well tolerated together with few systemic or ocular adverse events. It would be interesting to discover the pathway and molecular basis through which these medications interact and function. Long term studies would be useful to determine if these additive effects are sustainable and if the two drugs can be used continuously without clinically unacceptable side effects.

ACKNOWLEDGMENTS
Proprietary interest: Nil
Support: Grant from Singapore Eye Research Institute (SERI). Dr Aung is also supported by the National Medical Research Council, Singapore.

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Additive effect of unoprostone and latanoprost in patients with elevated intraocular pressure


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