

## Purpose

To measure the effect of glaucoma filtering surgery on oxygenation of the retina.

### Blood flow and oxygen delivery

Perfusion pressure in the retinal vasculature can be defined as the difference between blood pressure in the retinal arteries and veins (close to the optic disc).

The pressure in retinal veins is positively correlated with intraocular pressure (IOP) [1]. Decreasing IOP will increase perfusion pressure and increase retinal blood flow, assuming constant resistance to flow.

Oxygen delivery from the retinal vasculature is a product of retinal blood flow and the arteriovenous difference in oxygen saturation.

We studied the effect of lowering IOP by glaucoma filtering surgery on oxygen saturation in retinal arterioles and venules.

## Methods

Our automatic retinal oximeter [2] is based on a fundus camera. It yields fundus images with 4 wavelengths of light simultaneously. Two wavelengths, 605nm and 586nm, are used for calculation of oxygen saturation. Specialized software automatically selects measurement points on the oximetry fundus images and estimates the oxygen saturation in retinal vessels.

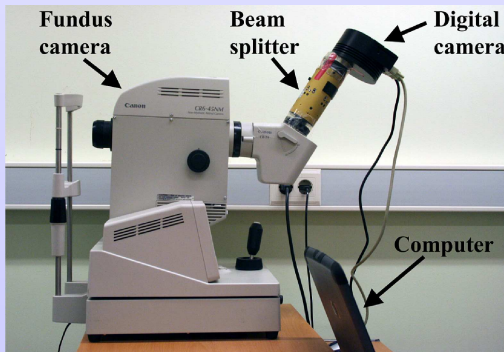


Figure 1. The retinal oximeter

Oximetry was performed in 1st and 2nd degree retinal arterioles and venules before glaucoma operation and again approximately one month after operation.

All patients with open angle glaucoma, with or without pseudoexfoliation, undergoing glaucoma surgery in Iceland in a 6 month period were invited to participate in the study. All patients took topical glaucoma drugs before operation and one also took oral acetazolamide (see table 1). The patients took no glaucoma drugs at the time of post-operative oximetry.

Twenty-five patients were measured before and after surgery. Six patients were excluded from analysis because of poor optical quality of the eye. Statistical analysis was performed with paired t-tests.

Table 1. Patients, n=19

Age	73±7 years (mean±SD)
Gender	12 males, 7 females
No. with pseudoexfoliation	7
Trabeculectomies, no. of eyes	14
Shunt operations, no. of eyes	5
IOP before operation (operated eye)	23±7mmHg (mean±SD)
IOP after operation (operated eye)	10±4mmHg (mean±SD)
The IOP was significantly lower after operation (p<0.0001)	
Topical medication before operation, no. eyes	
Timolol+Dorzolamide+Latanoprost	7
Latanoprost	3
Betaxolol+Latanoprost	2
Timolol gel+Latanoprost	2
Timolol+Pilocarpine+Latanoprost	1
Timolol+Brimonidine+Latanoprost	1
Pilocarpine+Propine+Travoprost	1
Brimonidine+Latanoprost+Acetazolamide	1
Timolol gel	1

## Results

Table 1. %Oxygen saturation in retinal vessels, n=19.  
Mean±SD

	Operated eye		Fellow eye	
	Pre op.	Post op.	Pre op.	Post op.
Arterioles	97±4	99±6*	96±5	96±5
Venules	63±5	63±6	64±6	63±8
AV-difference	34±6	36±8	32±6	32±8

\*The increase in saturation in arterioles in the operated eyes was statistically significant, p=0.046.

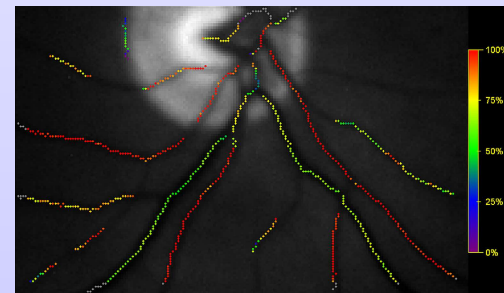
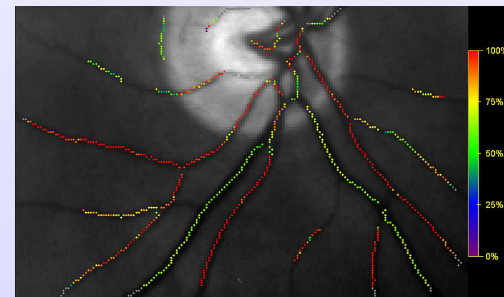


Figure 2. Pseudocolor maps of a fundus from the retinal oximeter, showing oxygen saturation in retinal vessels. Above: Before operation. Below: Same fundus after operation.

## Discussion

Our results show a 6% increase (34 to 36%) in the arteriovenous difference in oxygen saturation following glaucoma surgery. Berisha et al. [3] reported a 16% increase in optic nerve head blood flow following 6.8mmHg lowering in IOP. Assuming the same increase in blood flow in our study yields a 22% increase in oxygen delivery from the retinal vasculature following glaucoma filtering surgery. However, blood flow reports following glaucoma surgery are controversial [3-6].

6% increase in AV difference in saturation multiplied by  
16% increase in retinal blood flow [3]



22% increase in oxygen delivery

## Conclusions

Lowering IOP with glaucoma surgery results in a significant increase in retinal arterial oxygen saturation with constant retinal venous oxygen saturation. Combining our results with the reported increase in retinal blood flow, we conclude that oxygen delivery from the retinal vasculature is increased following glaucoma surgery.

## References

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