Axonal loss from acute optic neuropathy documented by scanning laser polarimetry

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Background/aims: Retinal nerve fibre layer analysis by scanning laser polarimetry has been shown to facilitate diagnosis of glaucoma while its role in glaucoma follow up is still unclear. A major difficulty is the slow reduction of retinal nerve fibre layer thickness in glaucomatous optic neuropathy. Eyes of patients were studied after acute retrobulbar optic nerve lesion in order to evaluate the usefulness of scanning laser polarimetry in documenting retinal nerve fibre layer loss over time.

Methods: Five patients who suffered severe retrobulbar optic neuropathy have had repeated measurements of the retinal nerve fibre layer using scanning laser polarimetry at various intervals, the first examination being within 1 week of injury.

Results: All eyes showed a marked decrease in peripapillary retinal nerve fibre layer thickness, which followed an exponential curve and occurred predominantly within 8 weeks of injury. Compared to a previous study using red-free photographs, scanning laser polarimetry showed retinal nerve fibre layer loss earlier in the course of descending atrophy.

Conclusion: Scanning laser polarimetry is useful for early detection and documentation of retinal nerve fibre layer loss following acute injury to the retrobulbar optic nerve. It seems to be a promising tool for follow up of individual glaucoma patients.

RESULTS

Each individual showed a marked decrease in peripapillary RNFL thickness during observation (Figs 2 and 3). The decrease occurred predominantly within the first 7–8 weeks after injury. Two patients (patients 2 and 5) showed an initial increase in RNFL thickness between the first and the second examination before the expected decrease occurred. The time course of axonal loss can be represented by an exponential decay with a relaxation time of 48.2 days, an amplitude of 83.2 and a base line of 34.6. The equation used was

\[ y = 34.6 + 83.2 \times e^{-t/48.2} \]

where \( y \) is the percentage of the initial retardation value, and \( t \) the time from injury in days (dark blue line in Fig 3).
means that after 48.2 days (that is, 7 weeks) the amplitude fell off to $1/e$ of its initial value ($83.2/e = 30.6$) and after 14 weeks to $1/e^2$ of its initial value.

**DISCUSSION**

Scanning laser polarimetry is a reproducible method to assess peripapillary RNFL thickness in healthy and glaucomatous eyes. In the present study we have demonstrated that progressive RNFL loss following acute injury to the retrobulbar optic nerve can be documented by scanning laser polarimetry as well. Injury to retinal ganglion cell axons in the primate visual system leads to ganglion cell death, termed descending degeneration. In squirrel monkeys the decrease in slow axonal transport and the degeneration of ganglion cells following transection of the retrobulbar optic nerve takes place between 3 and 6 weeks after injury. Interestingly, only few data regarding the time course of evolving atrophy of the RNFL following acute injury to the optic nerve were published in humans: Lundström and Frisen described the funduscopic findings at different stages of descending optic atrophy. Their case report describes little change of the RNFL in the first 4 weeks following injury as seen with red-free photography. The RNFL disappeared gradually during weeks 4–8. Recently, measurements of the RNFL using scanning laser polarimetry

![Figure 1](https://example.com/figure1.png)

*Figure 1* Right fundus of patient 1 before [A] and 16 weeks after [B] injury to the right intracranial optic nerve. The evolution of optic atrophy is clearly visible.

![Figure 2](https://example.com/figure2.png)

*Figure 2* Nerve fibre layer analysis in patient 5 at the initial [A] and last [B] visit after 9 weeks. The loss of peripapillary nerve fibres over time is evident both in the diminishing yellow-red tones of the false colour retardation image (above) as well as in the flattening of the double hump pattern (below).
were reported in a single patient on days 15, 30, 45, and 90 following severe intracanalicular optic nerve trauma. The initial measurement 2 weeks after injury appeared normal and even the examination at 30 days was only mildly abnormal before severe decrease of the RNFL occurred.

Using scanning laser polarimetry as well, but at shorter intervals and in a series of five patients, we observed a similar marked decrease of the RNFL thickness during follow up, recorded as changes of the retardation values. The main decrease in RNFL thickness appeared in the first 8 weeks after injury. Subsequent measurements did not reveal further major axonal loss. In our patients degeneration of the RNFL once started, seemed to follow an exponential curve. However, in patients 2 and 5, an initial unexpected increase of the retardation was noted within the first 2 weeks. Hypothetically, this finding may represent axonal swelling early in the course of trauma. In contrast with the case reported by Lundström and Frisen, in accordance with the case reported by Medeiros and Susanna, we find that decrease in RNFL thickness occurs already within the first 4 weeks after trauma in all patients. We ascribe this to the use of scanning laser polarimetry as opposed to red-free fundus photography. Niesen et al found that a comparison of RNFL assessment by scanning laser polarimetry with standardised red-free photography in 60 glaucoma patients and 24 healthy subjects did not yield equivalent information.

In conclusion, scanning laser polarimetry may be useful for early detection and documentation of RNFL loss following acute injury to the retrobulbar optic nerve. Of major interest would be to show whether scanning laser polarimetry can help to monitor glaucomatous optic nerve damage in individual patients over time as well.

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REFERENCES


Figure 3 Individual relative measurements of retardation values obtained by scanning laser polarimetry in the injured eye at each visit (indicated by circles) in all five patients, shown in different colours. The initial value was set as 100% and all subsequent values as percentages thereof. A calculated model is drawn as a solid dark blue curve.
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Notes