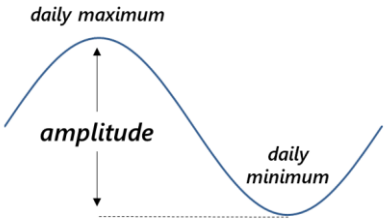
Amplitude of intraocular pressure fluctuation in healthy and glaucomatous eyes

Glaucoma

Glaucoma is characterized by irreversible vision loss through the progressive death of optic nerve fibres unless timely diagnosis and adequate treatment are provided. While elevated intraocular pressure (IOP) is no longer part of the definition of glaucoma, IOP remains the sole proven modifiable risk factor for the onset and progression of glaucoma[1].

IOP is known to fluctuate widely during the 24-hour (circadian) period[2-5] and IOP fluctuations have been related to disease progression[6, 7]. Hence, the range of IOP fluctuation may be relevant for the management of glaucoma.
This paper summarizes the typical values of tonometry-measured IOP fluctuation amplitudes found in the literature for healthy eyes and patients with different types of glaucoma.

Amplitude of IOP fluctuations in healthy eyes



In healthy subjects the amplitude of IOP fluctuations, defined as the difference between daily IOP maximum and minimum, usually varies between 2 and 6 mmHg over a 24-hour period[8-10]. Interestingly, IOP variations was found to be related to the axial length of the eye[11-14]. In healthy young adults, the amplitude of IOP variation has been shown to negatively correlate to axial length, with shorter eyes demonstrating larger amplitudes over the circadian cycle[12, 14]. However other studies show no differences between the two parameters[15, 16].

The table below summarizes the amplitudes of IOP fluctuation for healthy subjects with emmetropic (normal) and myopic (long) eyes. The mean amplitude of IOP fluctuations for all these healthy subjects is 4.0 ± 0.3 mmHg:

	All ***(Total or Mean ± SD)***	***Eyes*** ***(Total or Mean ± SD)***	
		Emmetropic	**Myopic**
Subjects (M/F)	138 (62/76)	64 (34/30)	74 (28/46)
Age (y)	24.6 ± 2.7	24.3 ± 2.5	24.9 ± 3.0
Axial length (mm)	24.5 ± 0.2	23.6 ± 0.2	25.5 ± 0.4
Amplitude of IOP fluctuation (mm Hg)	5.5 ± 2.8	5.8 ± 2.9	5.2 ± 2.7

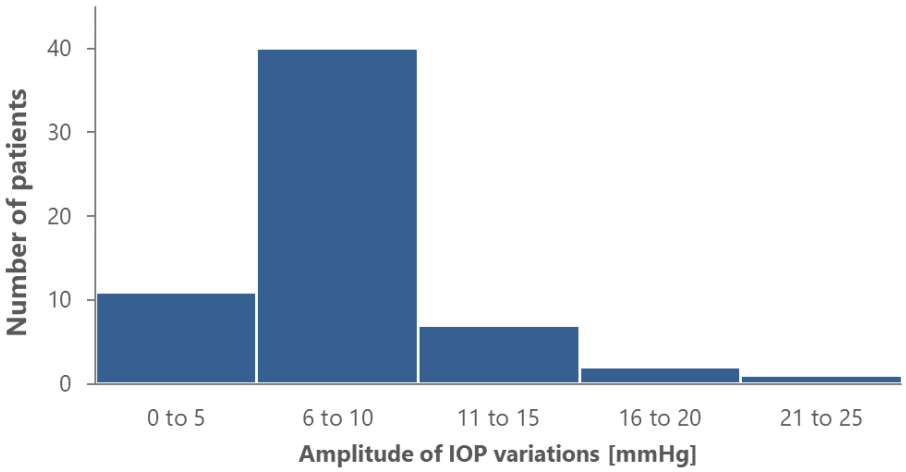
IOP fluctuations in hyperopic eyes (short axial length) have been evaluated in a single study[12]. The circadian amplitude of IOP fluctuations of the 9 hyperopic subjects included in this study was 12.8 ± 3.4 mm Hg, much higher than the amplitude of the 2 other groups mentioned above. However, because of the small sample size and the unicity of the study, the data are just provided for information.

Amplitude of IOP fluctuations in glaucomatous eye

Similarly to healthy subjects, IOP variations was shown to be related to axial length in a study comparing data from newly diagnosed young myopic open angle glaucoma (OAG) subjects with that of age-matched emmetropic OAG patients[17]. The results are summarized in the table below:

	Eyes (Total or Mean ± SD)		p-value
	Emmetropic	Myopic	
Subjects (M/F)	67 (35/32)	108 (52/56)	-
Age (y)	33.8 ± 7.7	32.6 ± 6.1	0.6
Axial length (mm)	23.5 ± 0.6	26.5 ± 1.4	<0.001
Amplitude of IOP fluctuation (mmHg)	6.0 ± 1.7	5.5 ± 1.5	0.047

In other studies, where the axial length was not taken into account, the mean range of IOP fluctuations during a 24-hour period varied between 6.7 and 9.4 mmHg in medically treated primary open angle glaucoma (POAG) eyes, including normal tension glaucoma (NTG), with upper values of about 25 mmHg[2, 18, 19]. As shown in the frequency distribution plot below, for the majority of the patients (66%) the amplitude of IOP variations was between 6 and 10 mm Hg [2, 18]:



In patients with angle closure glaucoma, the mean fluctuation of IOP amplitude, following laser iridotomy, was 6.3 ± 1.6 mmHg[20, 21]. This amplitude was found to significantly increase with increase in disease severity as shown in the table below:

	Eyes (Total or Mean ± SD)		
	PACS	PAC	PACG
Subjects	33	23	81
Age (y)	49.5 ± 8.1	56.6 ± 4.7	60.5 ± 3.7
Amplitude of IOP fluctuation (mm Hg)	4.4 ± 1.5	5.5 ± 2.3	7.6 ± 0.2

PACS: Primary angle-closure suspects; PAC: Primary angle-closure; PACG: Primary angle-closure glaucoma

Conclusion

The amplitude of IOP fluctuations is different according to subject's disease status. While it is around 5 mm Hg in healthy subjects, it is higher in POAG and PACG patients.

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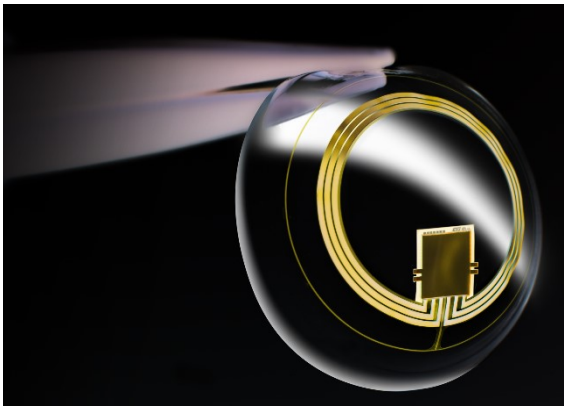
About Us



Sensimed SA, a Swiss company, has developed a unique technology platform on non-invasive soft contact lens-based solution. The first application, the SENSIMED Triggerfish®, provides an automated recording of continuous ocular dimensional change over 24 hours with the aim of revolutionizing glaucoma management enhancing personalization of patient care.

The SENSIMED Triggerfish® received the CE mark in 2010 and was approved by the U.S. Food and Drug Administration (FDA) in 2016. Since 2018 the device is registered in Japan at the Pharmaceuticals and Medical Devices Agency (PMDA).

Other non-invasive on-eye sensing applications are in development to provide clinically pertinent data with the same continuous monitoring approach. The Company is furthermore focused on expanding the knowledge of how this individual data can best be used in the clinical setting to deliver customized treatment. The data, analysed and modelled on an ongoing basis, is processed in an attempt to identify pathological patterns that can be used to differentiate indication, personalize treatment and assess efficacy of treatment.

The Company is directly positioned at the convergence between devices, treatment and information. Sensimed believes that with this global knowledge-based approach it will be possible to provide valuable insights that allow ophthalmologists to better understand and treat glaucoma.

Sensimed became a subsidiary of SEED Co., Ltd after the acquisition of a majority participation end of 2019.

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