Technical Note

Development of a device to prevent the late consequence of non-treated/lately diagnosed glaucoma

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Abstract. People residing in rural and remote areas (worldwide) have substantially worse outcome in early detection and diagnosis of glaucoma than those living in metropolitan areas. This gap can be reduced by improved glaucoma diagnosis activities in primary care, but there is little empirical evidence regarding use of tonometry in rural settings, or the expertise associated with quality of eye care. This article describes a feasibility study of a novel through-eyelid tonometer based on the use of an instrumented form of indentation and applanation tonometry.

Keywords: Glaucoma, intraocular pressure, cornea, eyelid, tonometry

1. Introduction

The degenerative disease glaucoma is the world's leading cause of preventable blindness. Glaucoma stems from optic nerve damage due to a buildup of intraocular pressure (IOP) in the eyeball [1]. It results into irreversible vision loss and considered as one of the leading cause of blindness worldwide [2]. It has been estimated that glaucoma affects 70 million people worldwide; however the fundamental causes remain unknown for many types of glaucoma [3]. The anterior segment of the eye is filled with a clear fluid called aqueous humor (AH). Glaucoma causes due to the resistance of the aqueous humor out flow, which in turn leads to an increase of the intraocular pressure (IOP) [4,5]. In the assessment of glaucoma the major risk factor is the elevated IOP. The measurement of IOP is important in early detection and diagnosis of glaucoma [6].

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Fig. 1. Device for detecting glaucoma.

According to the survey conducted by World Health Organization, the number of glaucomatous patients will increase to 80 million people worldwide in 2020 [7]. The intraocular pressure is a fundamental parameter of ocular health and disease, with major importance in the diagnosis and management of glaucomatous conditions. Chakrabarti et al. [8] described the evolution of tonometry used in IOP measurement and the different tonometry principles used in various tonometers since last two centuries. In the present study an innovative product is developed for detecting glaucoma.

2. Development of device

The present device for the detection of glaucoma is based on applanation and indentation principles (3123/MUM/2015IP). The key element of this innovative measurement method is contact plunger with an embedded piezo sensor. The device can be placed on closed eyelid and by applying a pressure (applanation force) on the eyelid through plunger with its tip the calibrated scale present in the control unit will indicate the level of glaucoma in patient's eye. The device is simple and convenient for use. The device is built by using simple electro-mechanical arrangement to be cost effective and economical (Fig. 1).

Further it can be used externally through eyelid and does not require anesthetic drops to be added in patient's eye. The device is used for screening patient's eye whether it is glaucomatous or non-glaucomatous, further focusing more insight on the patients having glaucoma. It helps the doctors or medical practitioners to find out the level of glaucoma in patient's eye. This serves the patient to avoid

Table 1
Findings of device for detecting glaucoma

Sr. No.	Subject	Age	Eye	Device findings	OP (Schiotz)
1	1	18	L	NG	17.3
2	2	51	L	NG	17.3
3	3	53	R	NG	17.3
4	4	50	L	NG	18.9
5	5	52	R	NG	17.3
6	6	65	L	NG	20.6
7	7	61	R	NG	17.3
8	8	67	L	NG	18.9
9	9	58	R	NG	17.3
10	10	36	L	NG	20.1
11	11	39	R	NG	21.9
12	12	55	L	NG	18.1
13	13	51	R	NG	19.7
14	14	60	L	NG	21.4
15	15	61	R	NG	19.7
16	16	35	L	NG	17.3
17	17	33	R	NG	15.9
18	18	55	L	NG	20.6
19	19	50	R	NG	18.9
20	20	50	L	NG	18.9
21	21	48	R	NG	18.1
22	22	80	L	NG	17.3
23	23	75	R	NG	15.9
24	24	25	L	NG	17.3
25	25	24	R	NG	17.0
26	26	50	L	NG	20.6
27	27	52	R	NG	22.4
28	28	80	L	NG	15.6
29	29	78	R	NG	17
30	30	48	L	NG	20.6
31	31	47	R	G	26.6
32	32	59	L	NG	18.5
33	33	58	R	NG	20.1
34	34	45	L	NG	19.7
35	35	44	R	NG	18.1
36	36	43	L	NG	18.0
37	37	42	R	NG	19.6
38	38	58	L	NG	21.4
39	39	57	R	G	25.3
40	40	56	L	NG	17.0

NG : Non glaucomatous **G:** Glaucomatous.

the further damage to his/her eyesight. The main body of the device comprises a main cylinder enclosing small plunger attached with piston and compression spring inside. The pressure sensor fixed between two piston (upper and bottom) measures the applanation force and represent it in the form of glaucoma indicator. The main cylinder carries an upper and bottom piston attached to plunger inside which allows the movement of the plunger. The top surface of the piston attached to the plunger is connected to the compression spring enables the compression of the spring due to the movement of the plunger. The tip of the plunger is provided with a flat circular cross section with a diameter of 3.06 mm required to applanate the cornea. The threaded bolt provided on the upper piston records the indentation of the plunger into the eye. In normal working the tip of the plunger is placed normal to the eyelid on patient's eye with a closed eyelid. The plunger exerts a pressure on eyelid to applanate the cornea. The pressure

Fig. 2. (a) Testing of device on patient's eye; (b) Comparison of results with tonometer (Schiotz).

exerted by the plunger on eyelid will transfer through pistons on pressure sensor the pressure sensor will transfer this applanated force into the control unit with the help of designed circuit by sensor connecting cables and designed circuit will convert this resistance into signal in the form of green and red indicator indicating the level of glaucoma. The green indicator represents the normal eye and red represents the glaucomatous eye. The recorded values will be directly indicated on the panel of the control unit. The device was tested on patient's eye for detecting glaucoma and cross verified by ophthalmologist with Schiotz's tonometer and digital pulpation technique (Fig. 2). The results are presented in Table 1.

3. Conclusions

The developed device can be used by any medical practitioner those are working in rural and remote areas. The patient will be more comfortable during the measurement of IOP. The device will totally eliminate the need of anesthesia and aid of expert ophthalmologist. This will help in screening the patient's eye in remote and rural areas.

Acknowledgments

Conflict of interest

The authors have no conflict of interest to declare.

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