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THE MOSES EFFECT DURING IN VIVO IMPRESSION TONOMETRY ON THE RABBIT EYE

BY

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Definition of the problem

Specification Nº IV of the American Committee for the standardization of impression tonometers provides definite norms for most parameters of tonometers. The size of the foot-plate hole was not considered in this specification. Experiments performed by MOSES and HAHN in 1958 and by MOSES in 1959 on enucleated human and rabbit eyes, demostrated that the magnitude of the scale reading of an impression tonometer is also affected by the size of the foot-plate hole, especially with high intraocular pressures. These authors were able to demostrate on the basis of photographic pictures and by using a translucent tonometer foot, that the plunger of the apparatus does not sink into a flattened-out cornea as was assumed until then, but into a cornea that prolapses into the hole. As a result of this the scale reading is decreased, especially in the higher pressure ranges, i.e., the scale reading is too high. Due to these findings specification Nº V of the American committee then fixed the upper limit of the size of the foot-plate hole at 3.7 mm. This failed to take into consideration, that according to the most recent tests of MOSES, the scale readings of tonometers with a foot-plate hole of 3.3 mm differ quite definitely from such with foot-plate holes of 3.7 mm and more.

The pending legal calibration requirements in the Federal Republic of Germany for all equipment which is used in the field of medicine for pressure measurements, made it essential to re-examine this situation once more. Beside experiments on enucleated human eyes (FRIEDRICH, 1966) we performed in vivo tests on rabbit eyes which we wish to report in this paper.

Methods

The Federal Physical-Technical Institute in Berlin made 6 tonometers available to us and these tonometers were almost identical in all parameters and within the tolerance limits, with the exception of the diameter of the foot-plate hole. This was 3.15 mm, 3.23 mm, 3.37 mm, 3.43 mm, 3.50 mm and 3.55 mm. All diameters thus where within the limits allowed by specification Nº V.

13 anesthetized rabbits served as experimental animals. Their weight ranged from 2.5 - 3.0 kg.

The apparatus used for pressure adjustment and pressure measurement manufactured by the Federal Physical-Technical Institute in Berlin, is reproduced in illustration Nº 1. A Nº 14 needle introduced into the anterior chamber at the

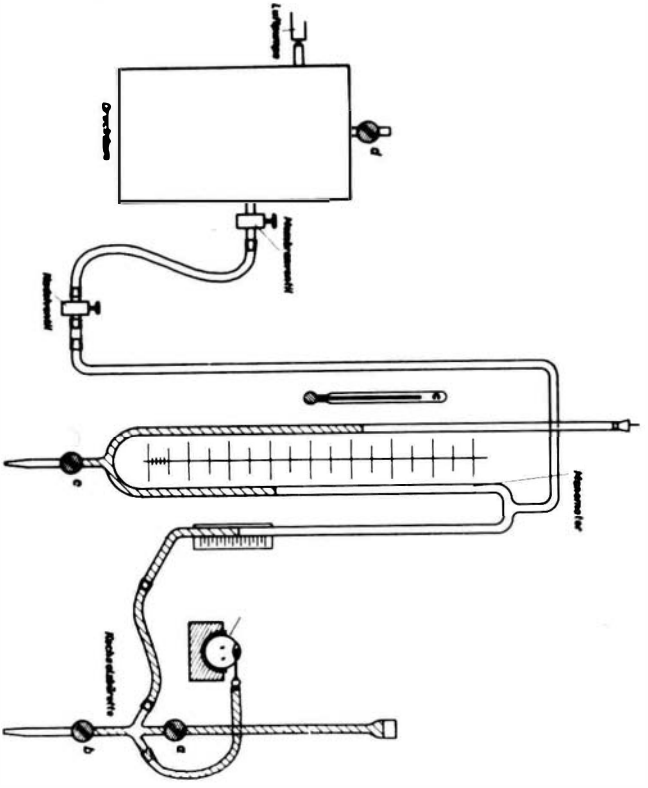

Fig. 1: Schematic representation of the apparatus, consisting of a pressure can, a manometer and a saline burette.

limbus formed the connection between the eye and the measuring apparatus. At a fixed pressure each of the 6 tonometers was applied, in different sequence,

to the eye bulb and the deflection of the pointer was read from the scale. These measurements were first performed with increasing and then with decreasing manometer adjustments. Thus we obtained 140-150 pressure reading (Pt) and pointer deflection readings (R) from each of the 6 tonometers.

Results:

The equation of Friedenwald $W/Pt = a + b \cdot R$ served as the basis for the evaluation of the results. W/Pt is obtained from the tonometer weight and the manometer reading, R is obtained from the corresponding pointer deflection. a and b can be determined by using regression calculations. A regression calculation was performed for each of the 6 tonometers. Illustration Nº 2 shows the straight line regression for tonometer Nº 2 (foot-plate hole diameter 3.23 mm) with the point distribution. The regression coefficient b became smaller as the size of foot-plate hole increased while the point of bisection with the ordinate of the system (a) became larger. The magnitude of b did not differ significantly in tonometers with foot-plate holes ranging from 3.15 to 3.37 mm or between the two tonometers with foot-plate hole diameters of 3.43 mm and 3.50 mm. Otherwise, definitely significant differences were present and these were entirely in the stated sense: the larger the foot-plate hole, the flatter was the angle of

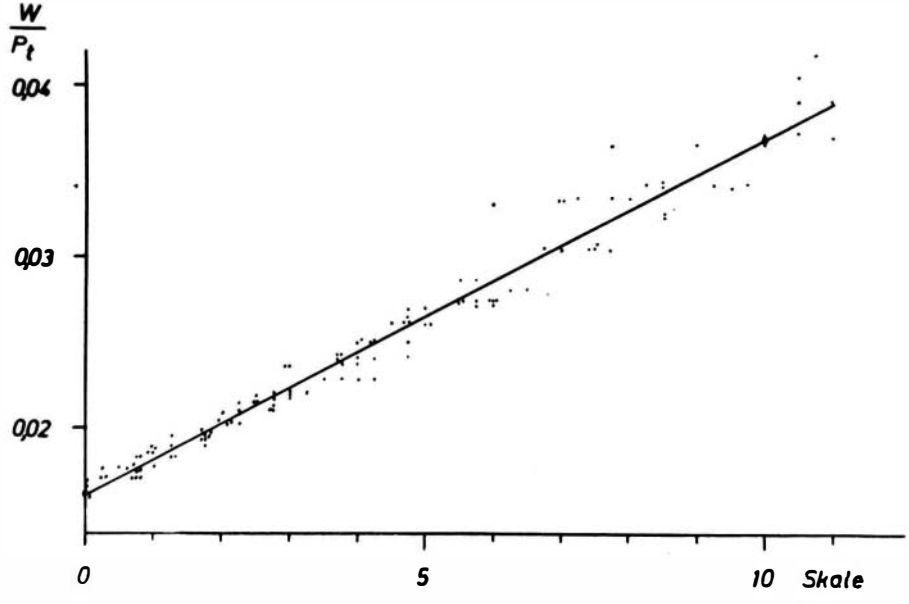

Fig. 2: Straight line regression of tonometer Nº II.

elevation of the regression straight line and the higher was the point of bisection with the ordinate (illustration Nº 3).

After calculation of the equation constants a and b it is possible to assign a pressure reading Pt to each scale reading R. The result for 3 tonometers is reproduced in illustration Nº 4. The correlation curves between Pt and pointer deflection R, even with our small differences in the diameters of the foot-plate holes, coincide with the curve obtained by MOSES in tests with larger differences. Even at pointer deflection 5 an already quite definite difference is present, which becomes increasingly larger towards O. With a pressure of 250 mm

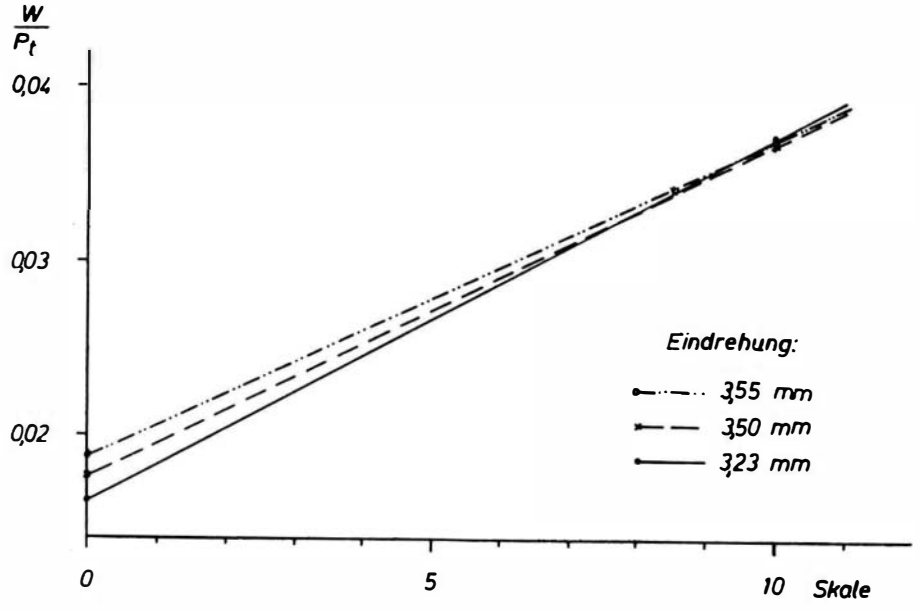

Fig. 3: Straight line regression of tonometers

fluid column (density of the manometer fluid = 2.17) the tonometer with the largest foot-plate hole diameter showed a scale reading of approximately 2, that with the smallest foot- plate hole of approximately 3. Due to the MOSES effect one may assume, that the pointer deflection 2 is the result of prolapse of the cornea into the foot-plate hole and thus is incorrect. The intra-ocular pressure obtained with such a tonometer is thus read too high from the calibration table. However, and this has been already pointed out by MOSES, this effect is larger in rabbits than in humans on account of the thinner rabbit sclera.

As these tests and the tests performed by FRIEDRICH on human human eyes have demonstrated, that the size of the foot-plate hole diameter affects the reading of the impression tonometer, it appears that more exact standardization of this parameter is essential. As production difficulties do not result from this, German legal calibration will require a foot-plate hole diameter of 3.3 ± 0.5 mm.

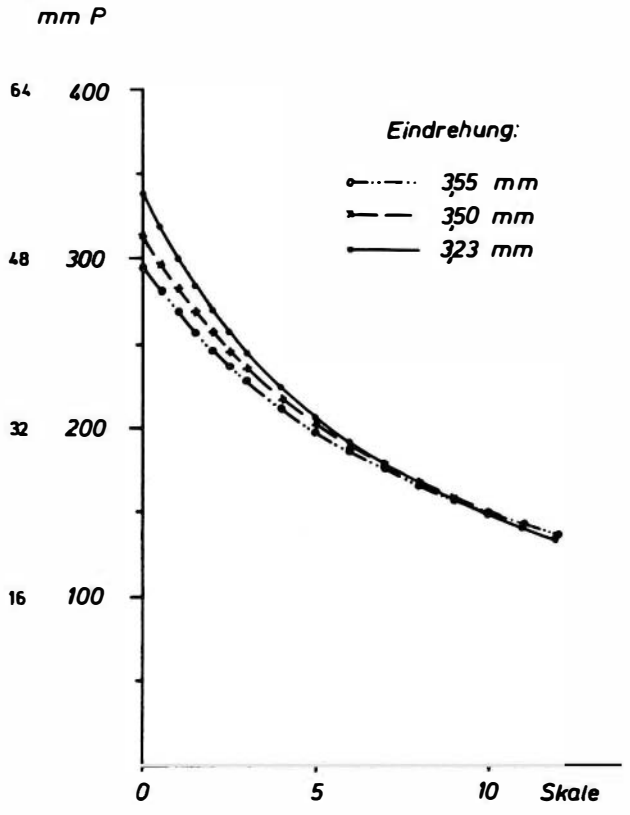

Fig. 4: Correlation curve between intraocular pressure (Pt) and pointer deflection (R) of tonometers II, V and VI.

Summary:

On the basis of in vivo tests on rabbit eyes the author reports about the effect of the diameter of the foot-plate hole of Schiötz-tonometers (Moses effect) on the measurement result. Even small differences of the diameter alter the measurement results in the manner stated by MOSES.

NECROLOGICA

Mr. Peter Vere Rycroft, M.A., M.D., F.R.C.S., D.O.

Peter Rycroft died tragically on January 6 th., as a result of a motor accident. He was thirty nine years of age. His early medical career as a student was at Trinity College, Cambridge University and his clinical studies were undertaken at St. Bartholomew's Hospital, London.

After a house surgeon's appointment at St. Bartholomew's and service in the Royal Army Medical Corps he decided to specialize in ophthalmology. He was House Surgeon and later senior Resident Officer at Moorfields Eye Hospital.

He obtained his Diploma in Ophthalmology in 1959 and became a fellow of the Royal College of Surgeons of England in 1963.

After his residency at Moorfields he was appointed ophthalmic registrar at Guy's Hospital and clinical assistant at the Queen Victoria Hospital, East Grinstead.

He was always interested in surgical ophthalmology and especially in the surgery of the cornea. He was a meticulous and talented surgeon but besides his practice of clinical surgery, he spent much time in active research into the biological aspects of corneal transplantation. He investigated extensively the changes occuring in stored donor corneal material which might affect the transparency of corneal grafts. Much of this research was carried out as research ophthalmologist to the Pocklington Eye Research Unit at the Royal College of Surgeons, and here he was able to enjoy working in close collaboration with his father the late Sir Benjamin Rycroft. His corneal research work formed the basis of his thesis for the degree of Doctor of Medicine at Cambridge University.

Last July, the Second International Corneo Plastic Conference was held at the Royal College of Surgeons, and Ophthalmologists and Plastic surgeons from thirty eight different countries took part. Owing to the sudden death of his father earlier in the year. Peter was left with the task of organizing the final arrangements. He worked with unbounded energy and enthusiasm to ensure the success of the meeting. This was no easy task since the conference consisted of five fully packed days of scientific and social activity. I know that everyone who had the pleasure of attending the meeting will agree that the outstanding success of the occasion was due above all to the organizing ability and hard work of Peter Rycroft encouraged and assisted at all times by his devoted wife Margaret.

He had travelled widely and had contributed to many ophthalmic meetings; his many friends from all parts of the world are, I know, saddened by his sudden death and feel it as a great personal loss.

To his wife, his three sons and his mother Lady Rycroft, we offer our sincerest sympathy.

Derek Ainslie

NOTICIAS

XVº Congresso Brasileiro de Oftalmología

Será realizado, em Pôrto Alegre, Rio Grande do Sul, de 27 de abril a 2 de maio de 1969, o XVº CONGRESSO BRASILEIRO DE OFTALMOLOGIA, que deberá reunir um número realmente extraordinario de especialistas, não só do Brasil, como também do Exterior.

Já estão bastante adiantados os trabalhos da Comissão Executiva do Congresso, assim constituída — Presidente de Honra, Prof. Ivo Corrêa Meyer; Presidente, Prof. Luis Assumpção Osório; Secretario, Prof. Mário Araujo Azambuja; Tesoureiro, Dr. Paulo Fernando Esteves.

Assim, já foi elaborado o programa cientifico, que constará de dois Temas Oficiais:

1º *Fotocoagulação e Laser*, tendo como Coordenador o Dr. Nelson Moura Brasil do Amaral (Rio de Janeiro) e, como Relatores, os Professores Sergio Cunha (São Paulo), Raul Rodriguez Barrios (Uruguay), Luiz Eurico Ferreira (Rio de Janeiro), Joaquin Marinho de Queiroz (Belo Horizonte) e os Drs. Laborne Tavares (Belo Horizonte) e Joviano Rezende (Rio de Janeiro).

2º *Glaucoma Congênito*, tendo como Relatores os Professôres Celso Antônio de Carvalho (São Paulo) e Nassim Calixto (Belo Horizonte).

Haverá, ainda, mais dois Simpósios: — um, sôbre *Olho e Rim*, que terá como Coordenador o Prof. Silvio de Abreu Fialho (Rio de Janeiro) e Relatores os Professôres Antônio Borras (Uruguay), Paulo Filho (Rio de Janeiro), Renato Toledo (São Paulo) e Paulo Braga Magalhães (São Paulo); e outro Simposio, sôbre *Olho Míope*, terá como Coordenador o Prof. Clovis Paiva (Recife) e Relatores os Professôres Rubens Belfort Mattos (São Paulo), Humberto Castro Lima (Salvador), Francisco de Paula Soares Filho (Curitiba), Egons Armando Krueger (Curitiba), Rivadavia M. Correa Meyer (Pôrto Alegre), Joaquim Ma-