

Effect of walking on the ocular tension in open-angle glaucoma

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In a previous paper (Leighton and Phillips, 1970) it was shown that a fall in ocular tension ($P < 0.01$) occurred in the right and left eyes of fourteen healthy young adults after 50 minutes' brisk walking. The result was as significant when a "correction" was made for the change in ocular tension during a control period of sitting on another day. The magnitude of the fall was dependent on the height of the initial ocular tension; right eyes $0.01 < P < 0.05$, left eyes $P < 0.01$.

It would obviously be useful to know if this trend is also present in patients with open-angle glaucoma. The effect on the ocular tension of a walk along an urban road was therefore compared with the effect of sitting in twelve patients with open-angle glaucoma.

Subjects and methods

Twelve recently diagnosed untreated cases of open-angle glaucoma* (five males and seven females) whose mean age was 67.4 years (range 58 to 83), attended on two consecutive mornings, I and II, for the tests:

- (1) Applanation tensions from both eyes: blood pressure from right arm: sitting for 50 minutes.
- (2) Applanation tensions from both eyes: blood pressure from right arm: on one morning, walking for 50 minutes: on the other morning, sitting for 50 minutes.
- (3) Applanation tensions from both eyes: blood pressure from the right arm.

The order in which patients walked or sat was randomized so that, of the twelve subjects, six exercised on day I and rested on day II, and six rested on day I and exercised on day II. Each phase of the investigation was done at the same time on the two consecutive mornings. A technician recorded the ocular tensions first from the right eye, then the left using a Goldmann applanation tonometer. Measurements of blood pressure (by D.A.L.) were taken from the right arm with the patient seated immediately after each applanation reading.

Results

OCULAR TENSION

Differences between applanation tensions 2 and 3 immediately before and after walking or sitting for right and left eyes are shown in Table I and the Figure (opposite). The mean fall after walking was 4.5 mm.Hg in right and left eyes ($P < 0.001$ each), and after sitting there were mean falls of 0.83 mm.Hg ($0.01 < P < 0.02$) in the right eyes, and 0.67 mm.Hg ($P > 0.05$) in the left eyes. When the fall after sitting was used as a control activity and subtracted from the fall after walking, the corrected fall after walking was again significant (right eyes $P < 0.01$; left eyes $P < 0.001$).

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*All had cupped discs, field loss, raised ocular tension, and open angles

Table I Changes in appplanation tension (mm.Hg) after walking and sitting, and the change after walking compared with the change after sitting in twelve patients with open-angle glaucoma

Eye	Right			Left		
	Change after		Fall greater (-) or smaller (+) after walking than after sitting by	Change after		Fall greater (-) after walking than after sitting by
	Walking	Sitting		Walking	Sitting	
Sub-jects 1-12						
1	-5	-1	-4	-4	-1	-3
2	-4	-1	-3	-5	-3	-2
3	-2	+1	-3	-4	+1	-5
4	-3	0	-3	-3	0	-3
5	-5	-2	-3	-8	-3	-5
6	-11	-2	-9	-7	+1	-8
7	-4	0	-4	-1	0	-1
8	-11	0	-11	-9	-1	-8
9	-2	0	-2	-1	-1	0
10	-4	-2	-2	-7	+1	-8
11	-3	-2	-1	-4	-1	-3
12	0	-1	+1	-1	-1	0
Total	-54	-10	44	-54	-8	46
Mean	-4.50***	-0.83*	3.67**	-4.50***	-0.67†	3.83***

*** P < 0.001 } significant A matched-pairs (related samples) Student's "t" test was used
 ** P < 0.01 }
 * 0.01 < P < 0.02 }
 † P > 0.05 not significant

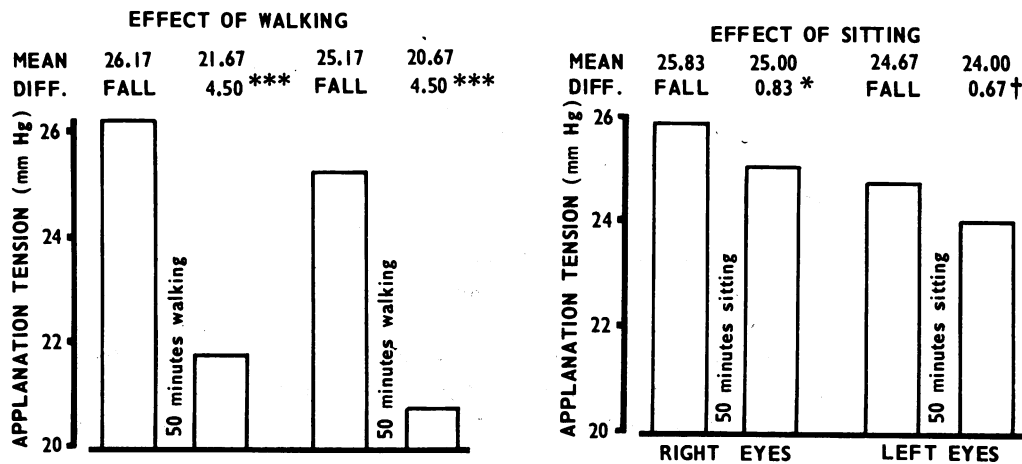


FIGURE Bar charts showing mean appplanation tensions (mm.Hg) from right and left eyes of 12 patients with open-angle glaucoma before and after :

LEFT 50 minutes walking
 RIGHT 50 minutes sitting

*** fall significant at P < 0.001
 * fall significant at 0.01 < P < 0.02
 † fall not significant P > 0.05

A matched-pairs Student's "t" test was used

A tendency for a greater fall in ocular tension to occur with a higher ocular tension before walking was present in both eyes, but reached significance only for right eyes; correlation coefficients were: right eyes $+0.646$; $0.01 < P < 0.05$, and left eyes $+0.454$; $P > 0.05$.

BLOOD PRESSURE

Changes in blood pressure recorded from the right arm are given in Table II.

The mean systolic blood pressure fell significantly after walking ($t = 2.958$, $0.01 < P < 0.02$). A fall after sitting was not significant (see Table II) ($t = 1.941$, $0.05 < P < 0.10$). The fall after walking was greater than the fall after sitting but the difference was not significant. Changes in the diastolic pressure were negligible.

Table II Mean blood pressure from right arm when seated before and after walking or sitting, each for 50 minutes on two consecutive mornings in randomized order in twelve patients with open-angle glaucoma

Mean blood pressure (mm.Hg)	Walking		Sitting	
	Before	After	Before	After
Systolic	143	134*	138	132
Diastolic	82	81	79	81

*fall significant at $0.01 < P < 0.02$

A matched-pairs (related samples) Student's "t" test was used

Discussion

The type of exercise undertaken by the twelve patients, a "stroll" along an urban road, was quite moderate. Marcus, Krupin, Podos, and Becker (1970) exercised twelve normal subjects maximally on a treadmill jogger for 4 minutes. A resultant fall in ocular tension coincided with a rise in both blood lactate and blood osmolarity, and a fall in blood pH.

Stewart, Le Blanc, and Becker (1970) found a fall in blood pressure after exercise as occurred in the present study (Table II). The fall in ocular tension may have been partly due to the coincidental fall in blood pressure, although no close correlation was found between the magnitude of the fall in ocular tension and that of the fall in blood pressure. Vasodilation in the muscles used in walking may have partly accounted for the fall in blood pressure: blood would tend to be diverted towards muscle and away from other organs, including the eye. Adrenergic activity would play a part in making these circulatory readjustments.

CIRCADIAN VARIATION IN OCULAR TENSION

The reduction in ocular tension found after walking was superimposed on a circadian variation which showed an almost consistent fall in mean values. Hence, in Table III (opposite), comparisons (a), (b), (f), (g), (h), (j) showed with one exception a fall in ocular tension. In (h), after sitting, falls of 0.83 mm. in right eyes (significant at $0.01 < P < 0.02$) and of 0.67 mm. in left eyes (not significant at $P < 0.05$) were found. In (j), between the

first and third appplanation readings when patients sat, ocular tensions fell by 2.25 mm. in right eyes (significant at $0.02 < P < 0.05$) and 1.08 mm. in left eyes (not significant at $P > 0.05$).

Table III Difference between mean appplanation tension readings 1, 2, and 3 taken on two consecutive mornings in twelve patients with open-angle glaucoma

(a) to (j) each refer to comparisons between paired mean appplanation readings, 1, 2, or 3 (*i.e.* 1-2, 2-3, or 1-3). Except in one instance (comparison (f) for right eyes) the mean ocular tension always fell

Comparisons between mean appplanation tensions 1 and 2						Fall in mean appplanation tension (mm.Hg) on mornings I or II	
I		Mornings or		II			
Mean appplanation tension			Mean appplanation tension				
1	2	3	1	2	3	Right eyes	Left eyes
(a)	1	2				-0.58	-0.25
(b)			1	2		-0.42	-0.42
(c)	1		1			-0.83	-1.00
(d)		2		2		-0.67	-1.07
(e)	1			2		-1.17	-1.42

I and II refer to first and second mornings respectively of investigation in chronological order (*i.e.* irrespective of whether walking or sitting). Between appplanation tensions 2 and 3 subjects walked or sat for 50 minutes, and the order in which this was done was randomized so that on mornings I or II, six subjects walked and six subjects sat. Differences between mean appplanation tensions 2 and 3 have therefore not been included

Comparisons between mean appplanation tensions 1-2, 2-3, or 1-3						Change in mean appplanation tension (mm.Hg) (-) = Fall (+) = Rise			
		Patients							
		Walked	or	Sat					
Mean appplanation tension (mm.Hg)			Mean appplanation tension (mm.Hg)						
1	2	3	1	2	3	Right eyes	Left eyes		
(f)	1	2				+0.25	-0.25		
(g)			1	2		-0.42	-0.42		
(h)				2	3	-0.83*	-0.67		
(j)			1		3	-1.25*	-1.08		

The differences between appplanation tensions 2 and 3 before and after walking are already included in Table I

A significant fall (*), $0.01 < P < 0.05$, occurred in only two examples. A matched-pairs Student's "t" test was used

DIFFERENCES BETWEEN OCULAR TENSIONS ON THE TWO CONSECUTIVE DAYS

Comparisons (c), (d), and (e) show that mean ocular tensions 1 and 3 were consistently lower on morning II than on morning I, hence the importance of randomization in the order of walking and sitting. Bankes, Perkins, Tsolakis, and Wright (1968) and Leighton and Phillips (1970) have commented on the tendency for ocular tension to fall on consecutive days.

The consistent tendency for the ocular tension to fall slightly:

- (A) during the two mornings
- (B) from morning I to morning II

should be borne in mind when patients are admitted to hospital for "phasing", or monitoring of the ocular tension. The small though consistent falls, **A** and **B** above, which occurred without any treatment, possibly due to a reduction in apprehension in the patients, may in part be erroneously ascribed to modification in medical treatment. Löhlein (1926) suggested that the variation in ocular tension without treatment should be determined before using medical treatment in glaucoma. Hager (1958) comments on the tendency for the ocular tension of glaucoma patients to fall when they are admitted to hospital even when no treatment is being given. This tendency to fall is probably less than might otherwise occur because of the removal of almost all exercise in hospital.

Summary

Twelve patients, whose mean age was 67.4 years (range 58 to 83), with open-angle glaucoma walked gently for 50 minutes on one morning and sat for 50 minutes at the same time of day on another consecutive morning. Six patients walked on Day I and sat on Day II while the other six sat on Day I and walked on Day II. A mean fall in ocular tension of 4.5 mm. was found in both right and left eyes after walking ($P < 0.001$). A fall in ocular tension was also found after sitting, significant ($0.01 < P < 0.02$) for right eyes only, but the fall after walking was significantly greater; right eyes $P < 0.01$, left eyes $P < 0.001$. The higher the ocular tension before walking, the greater was the fall. This trend was significant only for right eyes ($0.01 < P < 0.05$).

A nearly consistent tendency was found for the ocular tension to fall slightly:

- (A) during sitting, and
- (B) when readings from morning I were compared with those for morning II.

The systolic blood pressure fell significantly after walking ($0.01 < P < 0.02$).

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