# Effect of Marihuana on Intraocular and Blood Pressure in Glaucoma

JOHN C. MERRITT, MD, WILLIAM J. CRAWFORD, PhD, PAUL C. ALEXANDER, MD, ALFRED L. ANDUZE, MD, SOLOMON S. GELBART, MD

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Abstract: Marihuana inhalation was accompanied by increased heart rate and decreased intraocular and blood pressure in 18 subjects with heterogenous glaucomas. The hypotensive effects appeared in 60 to 90 minutes as the decrease in intraocular pressure (IOP) appeared to follow the decrease in blood pressure. In addition to any local effect, the mechanism of lowered IOP may also involve the decreased pressure perfusing the ciliary body vasculature as a result of the peripheral vasodilatory properties of marihuana. Postural hypotension, tachycardia, palpitations, and alterations in mental status occurred with such frequency as to mitigate against the routine used in the general glaucoma population. Our data indicate that further research should be directed to local means of delivering the ocular hypotensive cannabinoid to the glaucomatous eye. [Key words: blood pressure, glaucoma, heart rate, intraocular pressure, marihuana, Δ 9-tetrahydrocannabinol.] Ophthalmology 87:222–228, 1980

In 1971, Hepler[1] observed that marihuana smoking was accompanied by decreases in ocular tension in normal males. Later Lockhart et al[2] demonstrated an ocular hypotensive effect in Jamaicans with raised intraocular tension. These ocular effects, although of potential therapeutic benefit, have not been fully documented. Our study investigates the effect of marihuana inhalation on the intraocular pressure in various forms of glaucoma.

From the Division of Ophthalmology, Department of Surgery, Howard University College of Medicine, Washington, DC.

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Reprint requests to John C. Merritt, MD, 617 Clinical Sciences Building, 229 H, UNC School of Medicine, Chapel Hill, NC 27514.

## MATERIALS AND METHODS

The patients were attending the glaucoma clinic at Howard University Hospital, Washington, DC. Those with evidence of cardiac, neurologic, or psychiatric dysfunction were excluded, as were all women in the child-bearing years. After obtaining informed consent, 18 glaucoma patients (31 eyes) were selected for this study. Eight were hypertensive, four diabetic, and one asthmatic. Forty operative procedures had been performed on 17 eyes of 11 patients (Table 1). The visual acuities in the 31 glaucoma eyes are shown in Fig 1. Nine patients had used marihuana at least once, while the remaining nine patients had not.

The marihuana cigarettes were a blend of Mexican varieties grown at the Research Institute for Pharmaceutical Studies at the University of Mississippi and made available through the National Institute on Drug Abuse, Rockville, MD. Each 900 mg marihuana cigarette contained approximately 2% Δ 9-tetrahydrocannabinol (Δ 9 THC) by weight. Placebo therapy consisted of marihuana cigarettes that had the alcohol extractable cannabinoids removed leaving essentially a sugar and cellulose residue. Placebo cigarettes retained the same char-

Table 1. Patient Population (n = 18)

| | |
|---|---|
| Age | 28–71 yrs (median 45) |
| Race | 12 black, 5 white, 1 oriental |
| Sex | 12 males, 6 females |
| Diagnosis | 6 Secondary Glaucoma<br>12 Primary Open Angle (7 with JOAG)[3] |
| Operations | 40 procedures on 17 eyes (11 patients)<br>17 filtrations for OAG<br>15 for glaucoma resulting from congenital cataract, congenital glaucoma and neovascular glaucoma<br>4 scleral buckles<br>4 keratoplasties |

JOAG—juvenile open angle glaucoma; OAG—open angle glaucoma.

acteristic smell and taste as natural marihuana.

Glaucoma medications were discontinued in each patient 48 hours prior to testing. Initially blood pressure (BP) and heart rate (HR) were measured every five minutes while patients were sitting quietly for 15 to 20 minutes for baseline values. Intraocular pressures were then measured with a Goldmann applanation tonometer mounted onto a Haag-Streit slit lamp. One cigarette (placebo or marihuana randomly determined) was smoked over 10 to 20 minutes and the blood pressure (BP), heart rate (HR), and intraocular pressure (IOP) were measured at 15, 30, 60, 90, 120, 150, 180, and 240 minutes. Our results represent the mean ± standard error of the 31 glaucoma eyes. Statistical significance for these data was selected at $P < 0.05$ (paired t-test).

## RESULTS

Marihuana inhalation was invariably accompanied by significant increases in the heart rate. This tachycardia was present within two to three minutes and was maximum ($\bar{X} = 123.0 \pm 3.4$ beats/minute) at 15 minutes. Heart rates returned to control values within 90 to 120 minutes. Insignificant changes in heart rate occurred after inhalation of placebo (Fig 2). The IOP decreased 4.1 ± 1.5 mm Hg within the first 30 minutes after inhalation. The maximum decrease of 6.6 ± 1.5 mm Hg occurred at 90 minutes. There was no difference in pressure-lowering effects in those individuals whose angles were closed by synechiae when compared to those with open angle glaucoma. Control IOP was usually reached in four hours, although a longer hypotensive effect was demonstrable in several subjects. Insignificant changes in IOP occurred after placebo therapy (Fig 3). The systolic blood pressure was decreased ($\bar{X} = 11.4 \pm 3.0$ mm Hg) and diastolic BP ($\bar{X} = 5.1 \pm 1.0$ mm Hg) 60 minutes after marihuana therapy. In several patients the maximum decrease in blood pressure occurred within 10 to 15 minutes and was accompanied by postural hypotension in five cases. Blood pressures were not altered after placebo therapy (Fig 4).

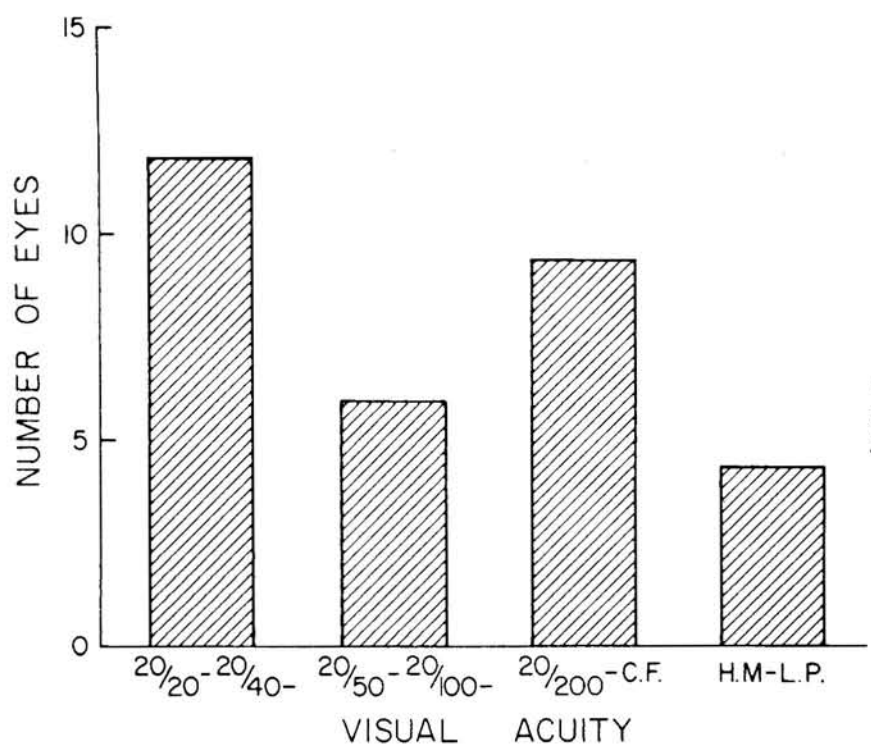


Fig 1. Visual acuity of 31 glaucoma eyes (18 subjects).

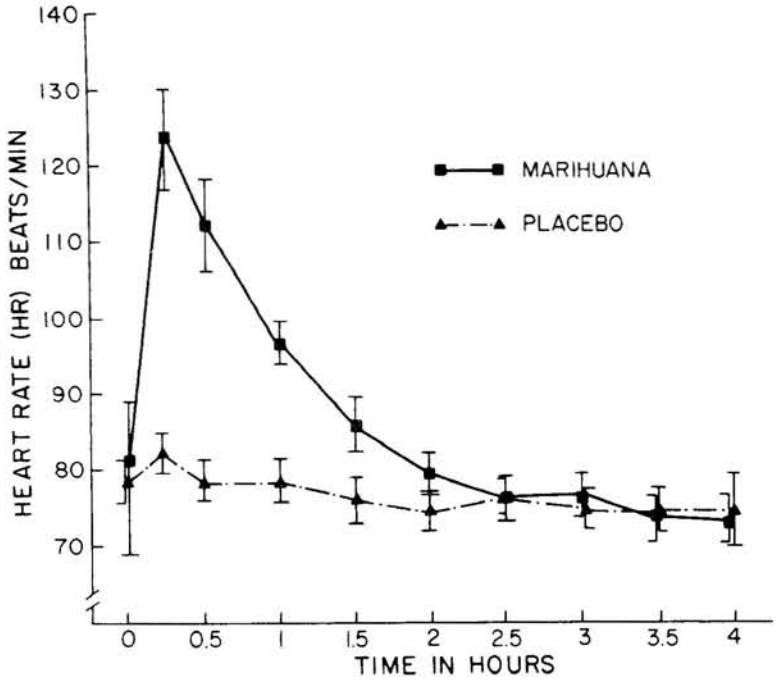


Fig 2. Heart rate (mean ± standard error) after inhalation of marihuana and placebo.

## SIDE EFFECTS

Table 2 lists the side effects observed after marihuana therapy in 18 subjects. Postural hypotension, occurring in five subjects, was the most serious complication encountered.

**Case 1.** The patient is a 28-year-old man who had never used marihuana. The visual acuity in the normal right eye was 20/15 and light perception in the left eye. Poor visual function in left eye was the result of a tractional retinal detachment, band keratopathy and glaucoma secondary to complete angle closure by a fibrovascular membrane. The IOP varied from 40 to 50 mm Hg on epinephrine 2%, diamox 500 mg twice daily, and previous cryotherapy. The subject was tested with marihuana seven days after receiving his last glaucoma medication. He successfully smoked a 900 mg cigarette in the sitting position over 10 to 15 minutes. Ten minutes after completion, the heart rate fell to 60 beats/minute with the blood pressure becoming inaudible. He be-

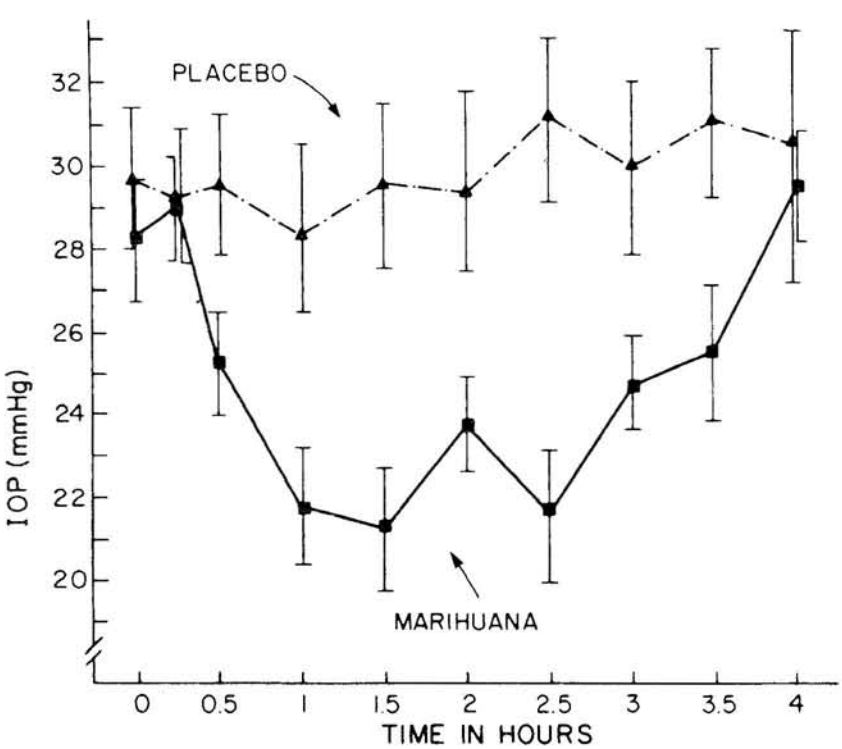


Fig 3. Intraocular pressure (mean ± standard error) in 31 glaucoma eyes after marihuana and placebo inhalations.

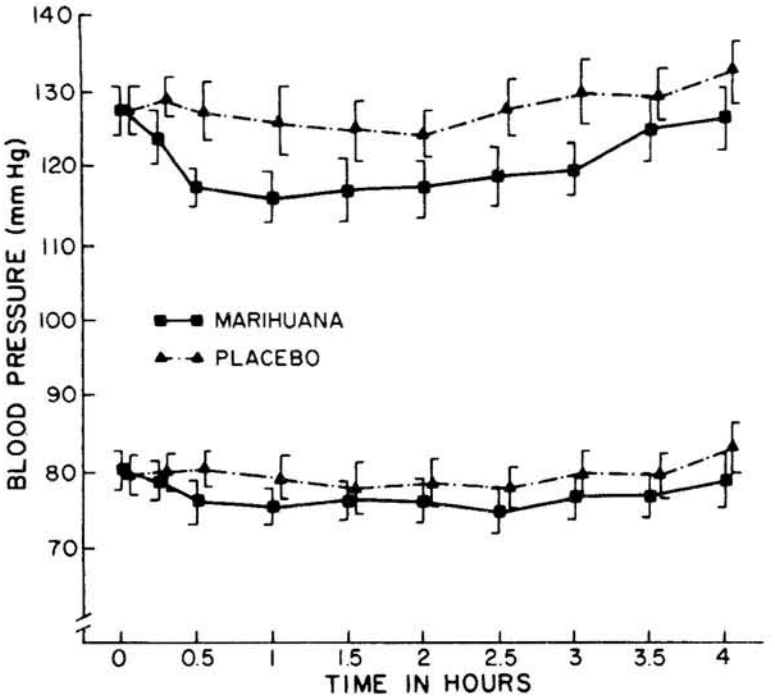


Fig 4. Systolic (*upper*) and diastolic (*lower*) blood pressure after inhalation of marihuana and placebo (mean ± standard error).

came pale, cold, and sweaty as a result of the sudden decrease in blood pressure. During this period the IOP was 1 to 2 mm Hg in the right eye and 26 mm Hg in the left eye. The subject was immediately placed in the reclining position with the blood pressure rising to 110 mm Hg and IOP increased to 5 mm Hg in the right eye and 41 mm Hg in the left eye as measured with a hand-held applanation tonometer (Fig 5).

**Case 2.** The patient is a 31-year-old man whose glaucoma stemmed from multiple surgical procedures for primary congenital glaucoma. The visual acuities were bare light perception in the right eye and counting fingers at two to three feet in the temporal field in the left eye. Previous medical therapy included timolol maleate 0.5% in both eyes twice daily, epinephrine 2% in both eyes twice daily, and pilocarpine 6% in the left eye four times a day. Carbonic anhydrase inhibitors were associated with kidney stones and the patient admitted that he had become a frequent (daily) user of marihuana for the past five to six years. On test day 1, he smoked a 900 mg marihuana cigarette over a 10-minute period. There were insignificant changes in IOP and virtually no change in blood pressure (Fig 6). Because of this poor response, and his previous experience with marihuana, he was tested on another day with two marihuana cigarettes which he inhaled over 25 minutes in the sitting position. Ten minutes after completion, he became nauseous, lightheaded, cold, sweaty, and his blood pressure became inaudible. The heart rate decreased to 60 beats/minute and the IOP fell to 14 mm Hg (right eye) and 3 mm Hg (left eye). The subject was placed in the reclining position with a resulting rise in both the blood pressure and intraocular pressure (Fig 7).

Table 2. Side Effects of Marihuana

| Effect | Number of Cases |
|---|---|
| Anxiety with tachycardia and palpitations | 8 |
| Postural hypotension | 5 |
| Alterations in sensorium (hunger, thirst, euphoria, drowsy, feeling cold) | 18 |
| Bulbar conjunctival hyperemia and ptosis | 9 |

## DISCUSSION

Our study verifies that marihuana lowers both intraocular pressure and blood pressure in a heterogenous glaucoma population. The magnitude of these hypotensive effects depends on the initial pressure levels, as greater decreases in BP and IOP were evidenced in subjects with essential hypertension after single dose administration of marihuana.[4,5] The exact mechanisms by which cannabinoids effect ocular tension in man are poorly understood. In rabbits, topical[6] and intravenous[7,8] THC alter aqueous dynamics primarily through the central nervous system although intact peripheral adrenergic receptors are necessary for the full expression of the THC's effect. Intravenous Δ 9 THC in rabbits with unilateral superior cervical ganglionectomy causes a 25% pressure reduction in the normal eye, with a significantly reduced

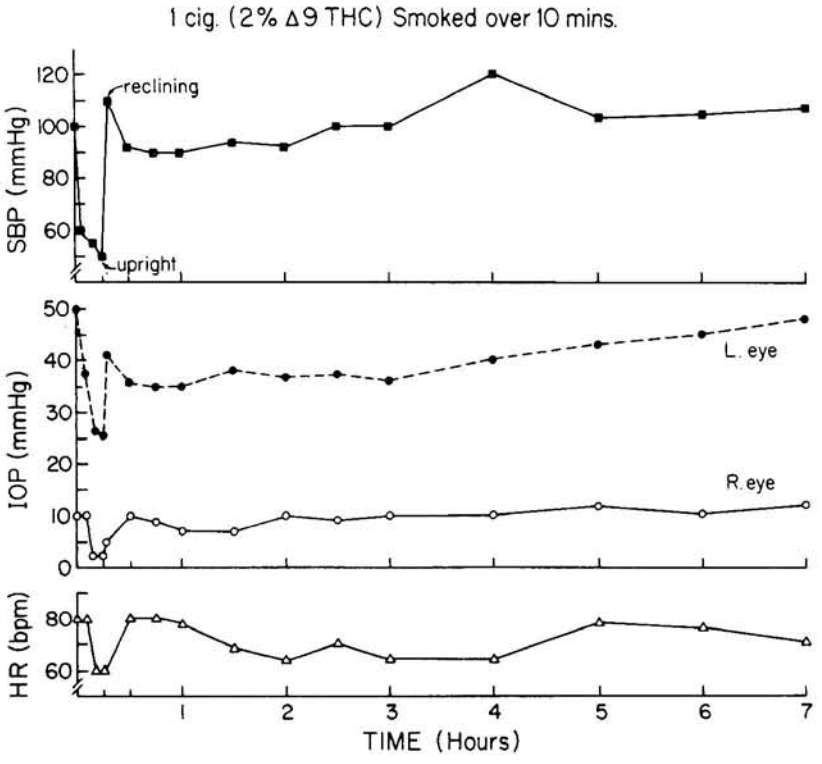


Fig 5. Inhalation of marihuana in marihuana-naive male (case 1).

effect in the eye on the side of the ganglionectomy. Similarly the beta adrenergic blockers, propranolol and sotalol, attenuate the THC pressure-lowering effect while the alpha blockers (phentolamine and Regitine) have been reported to inhibit the THC-induced increase in total outflow facility by 25% in rabbits.[9] Obvious species differences and lack of pharmacologic evidence for adrenergic receptors in the human eye preclude meaningful comparisons with the present study.

In addition to any local effect, the systemic effects of marihuana must be considered. Acute alterations in systolic blood pressure, a major modulator of IOP,[10–12]

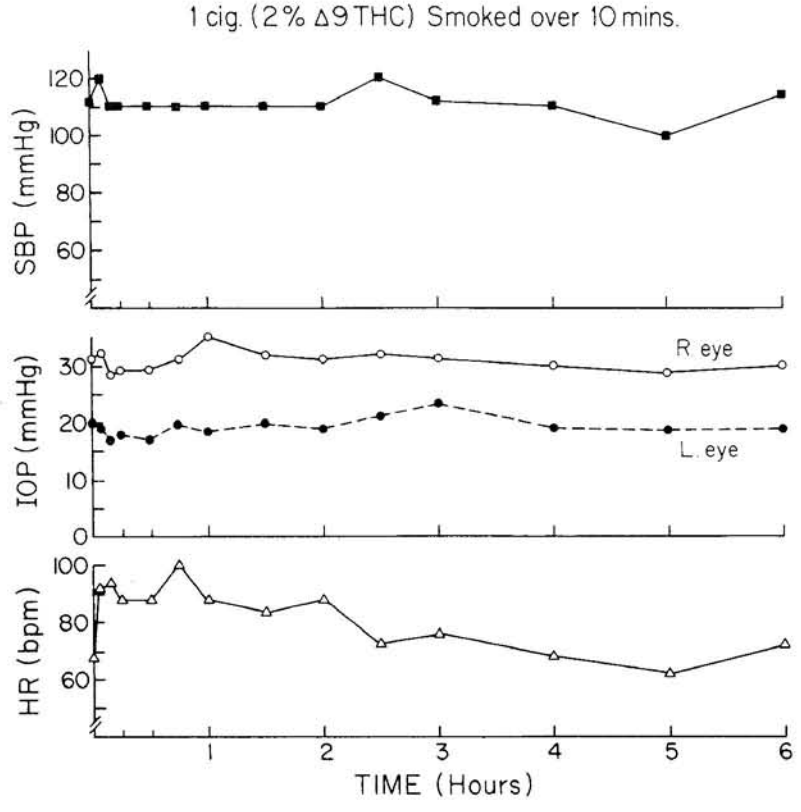


Fig 6. Inhalation of 0.9 g marihuana cigarette (2% Δ 9 THC) in a marihuana-experienced male (case 2).

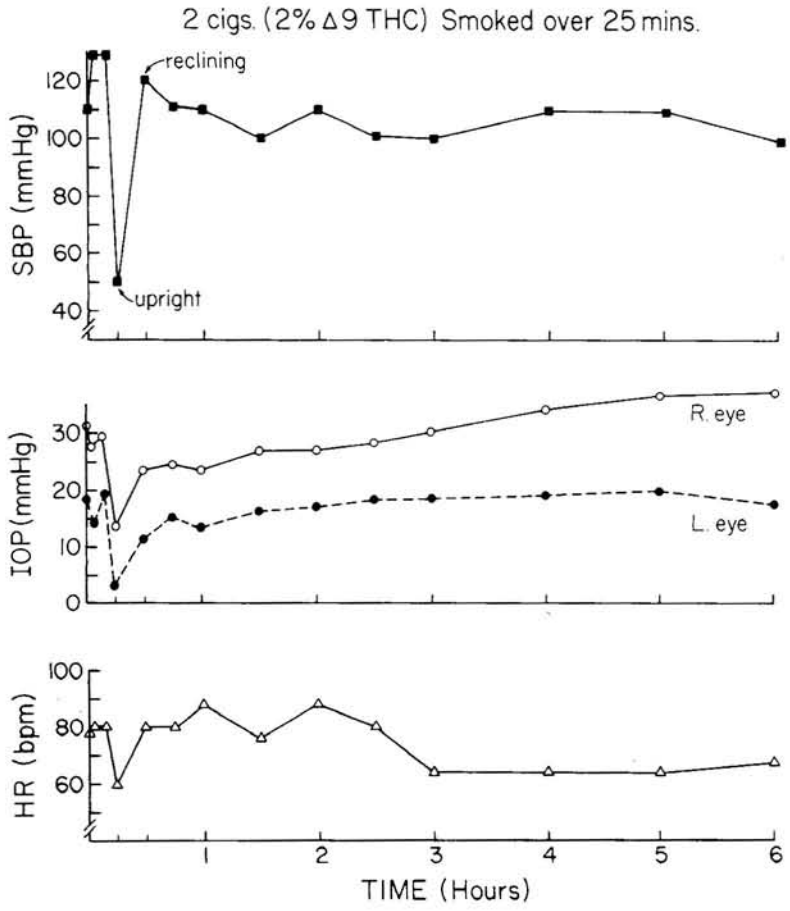


Fig 7. Inhalation of two marihuana cigarettes (2% Δ 9 THC) in marihuana-experienced male (case 2).

could account for the directional changes observed in IOP, as was documented in the two subjects described with postural hypotension. The marihuana-induced tachycardia may result from stimulation of beta$_1$ adrenergic receptors in the heart. Although this tachycardia has been attenuated by propranolol in normal males,[13–16] Benowitz et al[17] have shown that Δ 9 THC exerts both a beta$_1$ stimulatory and parasympathetic inhibitory effect on the heart. Pretreatment of marihuana-experienced males with atropine and propranolol, completely abolished the effect of Δ 9 THC on the heart rate and blood pressure. Similarly, bronchodilatory effects which occurred in one asthmatic patient after marihuana corroborated other studies[18] that suggest beta$_2$ agonist properties of Δ 9 THC on lungs. The observed side effects in the patients who never used marihuana were more severe than in subjects who had previously experienced these effects. Anxiety concerning the tachycardia, palpitations, and postural hypotension predominated rather than euphoria. It is because of the frequency and severity with which the untoward events occurred that marihuana inhalation is not an ideal therapeutic modality for glaucoma patients.

## ACKNOWLEDGMENTS

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