An inquiry into the action and uses of atropia / by Alex. Fleming.

with Dr Fleming's

AN INQUIRY Compliments

INTO THE

ACTION AND USES OF ATROPIA.

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Physiological Action.—Local Action.—When a solution of atropia (1 grain of the alkaloid to 10 drachms of the menstruum) of the same strength as that which I employ for internal use, but made without spirit,[1] is well rubbed into the skin, no change results in the sense of touch—the sensibility to common impressions, or to temperature. The colour of the part is not altered, nor is its contractility—as evidenced by the goose-skin produced by the galvano-magnetic current and wire brush of Duchenne—either increased or impaired. I have determined these points by repeated experiments. Further, from several trials which I have made on worms and the small intestines of rabbits, I conclude that atropia is not a local paralyzer, as has been commonly inferred, either from its supposed mode of action on the iris, or from its curative influence in spasmodic diseases. The alkaloid appeared rather to quicken the contraction of the parts to which it was applied.

Painted on the mucous membrane of the mouth and throat, it dries the part, and—chiefly as secondary effects—impairs both its feeling and movement, perverting the taste, and causing much difficulty of swallowing. These symptoms are much relieved by moistening the parts with water.

Applied directly to the smaller arteries, atropia constricts them (Jones); and this effect may continue for many hours.

On the Eyeball.—The same solution of atropia, dropped on the conjunctiva, in a few minutes widens the pupil, and after a much longer interval impairs the sight and lustre of the eye to which it is applied. The eye is misty, and cannot read print, easily seen by its

[1] See my paper "On the Internal Exhibition of Atropia and of Strychnia," in the January number for 1863 of the Edinburgh Medical Journal, p. 625.

healthy fellow. This has been generally referred to diminished sensibility of the retina; but my observations (made in 1856)[1] prove beyond doubt that it is altogether due to the width of the pupil, and the loss of power in the eye to adapt itself to near vision. That it is in part due to the large pupil admitting too many and too divergent rays is shown by the vision being improved in a dusky light, and in looking through a hole—smaller than the dilated pupil—in a black card held close to the eye. But it is especially due to the inability of the eye to adjust itself to near vision. The defective sight is more marked the closer the object, and diminishes with distance. As the influence of the atropia is wearing off, while yet the difference between the two eyes is decided with a near object, scarcely any difference is perceived with a distant one. The type of a book appears smaller to the atropised eye than to its fellow at the same distance. Hence vision with both eyes conjointly is confused, and, for reading, the dilated eye must be covered.

The solution of strength indicated above (1 grain to 10 drachms) serves well for ordinary use to dilate the pupil. To obtain the deeper effects upon the eye a stronger solution of 3 grains to 10 drachms should be employed. This reduces the iris to a mere line, and completely impairs the sight. The blindness continues from one to four days, and subsides some time before the pupil regains its normal size. The eye thus atropised bears the sun's rays better than its fellow, which seems to show that the iris itself is, in part at least, the seat of the incident impressions which contract the pupil and protect the retina. When this stronger solution is applied carefully to the outer side of the eye, the adjoining or outer part of the circle of the iris dilates some time before that of the inner side. This fact points to a strictly local action. Atropia does not redden the conjunctiva. It has no action on the iris of the dead eye.

Among other observations which I have made on the atropised eye, I found that in adapting the telescope to it the instrument requires to be lengthened, as compared with the other eye; but the focus having been adjusted, vision is perfectly clear, although the eye, without the help of the telescope, be absolutely blind. Indeed, several of those who made trials with the telescope maintained that they saw better with the atropised eye—a fact deserving of the astronomer's attention. In using the microscope with the atropised eye, the object has to be removed a little farther from the instrument; but the focus having been adjusted, vision is as good as with the healthy eye.

I was able to make the smaller image of the atropised eye, as compared with the other, very manifest by means of the reflecting stereoscope.

Mode of Action.—The atropised eye is altered as if for distant

[1] Medical Times and Gazette, 1857, vol. i. pp. 270 and 345.

vision. The pupil dilates, and at the same time I believe that the lens recedes and diminishes the distance between it and the retina. The following is my explanation of the mode in which these results are produced.

The erectile structure of the iris has been of late too much overlooked in discussing its movements — the singular softness of which appears to imply something more than muscular contraction.

The iris may be congested and the pupil contracted by relaxation of its arteries letting more blood into it, or by compression of its veins impeding the flow from it; and it may be emptied of blood and relaxed, either by contraction of its arteries or by relaxation of its veins, or both conditions may co-operate. The ciliary processes have a mixed erectile and muscular structure, not unlike that of the iris, and it is a most feasible supposition that the lens is advanced by their turgescence, conjoined with contraction of the ciliary muscle, and recedes on their relaxation—the former being an active, and the latter the quiescent condition of the parts.

The sympathetic nerve supplies at the same time contractile power to the arteries and to the radiating fibres of the iris; and it seems most probable that in ordinary dilatation of the pupil the same reflex influence stimulates conjointly the contractile arteries entering the iris and the radiating fibres. These being always associated in action, we can understand that an agent like atropia, directly contracting the arteries entering the iris, will draw into movement by sympathy its radiating fibres, the contraction of which is already made easy by the emptiness of the erectile tissue.

For near vision in normal accommodation I believe that the *pupil contracts and the lens advances.* The veins of the iris and ciliary body are, I believe—as formerly suggested by Wallace, Cooper, and Smee—at the same time compressed by the ciliary muscle causing turgescence of their erectile parts. The turgescence of the iris co-operates with the contraction of its circular fibres to close the pupil. The turgescence of the ciliary body must exert pressure on the vitreous humour, which, diffused equally through that fluid, takes effect on the only yielding point—the lens—and pushes it forward, just as a patient is raised by pressure on the side of a water bed. The ciliary and iridial muscles concerned in these associate movements receive their nervous supply from the same source or third pair.

When atropia is applied to the eye I believe that it reaches by imbibition, *first*, the arteries entering the iris—constricts them—impedes the flow of blood to, and relaxes its tissue. The constriction of the arteries of the iris, with its consequent relaxation, draws into action, *by functional sympathy* (and without the intervention, by reflex action, of the brain or cord), the radiating fibres, and dilates the pupil. Sinking deeper into the eye, the alkaloid

reaches, *secondly*, the ciliary processes, and relaxes their erectile structure and causes distant vision. The relaxation of the ciliary body must cause the advance and expansion of the vitreous humour around the lens; while the lens itself recedes, to occupy the place of the displaced fluid. The ciliary muscle is considered by some anatomists to have both circular and radial fibres, like the iris, and animated, in like manner, by the third and sympathetic nerves.

That the lens recedes and approaches the retina in the atropised eye, is proved by the vision being clearer with distant than with near objects, and by its furnishing a smaller image than the healthy eye of an object at the same distance from both.

According to the view here stated, the normal accommodation of the eye to near and distant vision depends essentially on a change in the position of the lens, brought about in the manner described. The experiments of Cramer and Helmholtz, on the other hand, refer this power to a change in the form of the lens. Near vision is effected, according to them, by an increase in the thickness or convexity, and distant vision by a flattening of the lens. This body certainly does not look as if it could be made thick and thin by muscular action; and as it must be most difficult to make the measurements of its antero-posterior diameter in the living eye, on which this opinion is founded, I would desire to see them verified by others. I say this with sincere respect for these most able oculists. Assuming their observations, however, to be absolutely correct, the change in the form of the lens may be only one part of the phenomena of even normal accommodation; and certainly it is quite compatible with my theory of the mode of action of atropia, in widening the pupil and causing distant vision,—for it must not be forgotten that my explanation applies to both of these changes.

In the dead body, Helmholtz found that the lens has the form—thick and convex—of that adjusted for near sight, which is curious, seeing that near vision is the active state in the living eye.

The remarkable precision of the phenomena produced by atropia in the eye, and the comparatively gradual manner in which they are accomplished, are more easily reconciled with my explanation; and, without attaching too much importance to them, some facts in practical medicine which harmonize with it, may now be stated. For many years, I have noted that patients suffering from atonic and exhausting disease, and especially from such as enfeebles in a marked manner vital turgescence and erectile power, as enteric fever, diabetes, anæmia, Bright's disease, and diphtheria, are disposed to wide pupil and distant vision. There is also good reason to believe that contracted arteries, wide pupil, and far sight or virtual blindness, are the *early* phenomena in the eye of the epileptic paroxysm, of fainting, of excessive loss of blood, and of pure seda-

tive poisoning. Again, those conditions which check the arterial flow to the eye tend to dilate the pupil, such as aneurism in the chest and neck impeding the passage of blood into and through the carotid, a tumour pressing on, or a plug in the vessel. Worms and disease of the belly in children dilate the pupil and impair the sight, probably by reflex action through the sympathetic nerve—exciting the radial fibres of the iris and contracting the cerebral arteries. Hence, also, in all likelihood, the train of anæmic head-symptoms so characteristic of tape-worm.

On the other hand, those conditions which favour arterial plethora or venous congestion of the head tend to contract the pupil —such as dilatation and loss of contractility of the aorta and carotid—giving passage to a larger stream, and checking its force less, than the normal vessel. Aneurism of the innominata closing the subclavian and leaving the carotid free will increase the force of the blood current in the latter, and this will be further augmented if the carotid be diseased, dilated, inelastic, and non-contractile.

It does not fall within the scope of this paper to allude to the beautiful researches of Budge, Waller, Brown-Séquard, Von Graefe, Bernard, Harley, Bell, Hughes, and others, into the physiology of the iris, and of the nerves which preside over its movements, nor to the very useful application of this knowledge to practical medicine by Macdonnell, Gairdner, and Ogle, who have traced contraction and dilatation of the pupil to pressure on, or disease involving the cervical sympathetic, and other parts of the nervous system connected with the movements of the iris. But, in examining cases of aneurism, and of tumour in the neck and thorax, accompanied by alterations of the pupil, it is well also to bear in mind the causes of change in the size of the pupil to which I have adverted, and to make careful inquiry into the condition of the arterial and venous currents in the neck.

The results related in this paper were obtained chiefly by observations on the eyes of my students in the Queen's University, who most cheerfully gave me every assistance in my inquiries. I have also made numerous experiments on the eye of the cat and rabbit, some of which will be recorded in the appendix to this memoir.

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