Commentary: Exercise, intraocular pressure, and ocular blood flow

An article in the current issue of the *Indian Journal of Ophthalmology* (IJO)[1] analyzes the influence of aerobic exercise on intraocular pressure (IOP) and ocular perfusion pressure (OPP) in patients with primary open-angle glaucoma (POAG). The authors noted a significant decrease in IOP and an increase in OPP after short-term and long-term aerobic exercise and concluded that aerobic exercise is beneficial for patients with POAG.

IOP is known to decrease following aerobic exercise. In fact, as early as 1965, Cooper *et al*.[2] studied the link between IOP and exercise and found that exercise transiently decreases IOP. However, the underlying mechanism that causes the decrease in IOP remains unclear and multiple reasons have been suggested to explain it. First, the loss of sweat and water could increase the colloidal osmotic pressure of plasma during exercise. This would result in decreased production of aqueous humor.[3] Second, exercise leads to an increase in blood supply primarily to the limbs. This renders the oculus ischemic, resulting in decreased production of aqueous humor.[4,5] Third, activation of the sympathetic nervous system during exercise causes choroid vasoconstriction. The reduced choroidal blood flow decreases the IOP.[6] Fourth, increase in catecholamine concentrations following exercise could cause IOP reduction by reducing aqueous humor formation and increasing trabecular outflow facility in a beta-2 adrenergic receptor (ADRB2)–dependent manner.[7] Yan *et al*.[8] suggested that aerobic exercise could cause sympathetic nerve stimulation, resulting in expansion of the trabecular meshwork and Schlemm's canal, which in turn leads to IOP reduction.

Physical exercise can be dynamic or isometric. Dynamic exercise is work performed by a muscle while changing the length of that muscle (e.g., walking, running, or cycling

for a period of time). Isometric exercise is work performed by a muscle while maintaining constant muscle length (e.g., assuming a squat position for a period of time). Studies have shown a decrease in IOP after either isometric or dynamic exercise. Decreased blood pH, hyperosmolarity, and elevated blood lactate are the proposed mechanisms for IOP lowering following dynamic exercise. IOP decrease in isometric exercise correlates with hypocapnia, whereas in dynamic exercise lower IOP has been shown to be independent of carbon dioxide levels. A study comparing the two has shown that dynamic exercise has more pronounced IOP-lowering effect than isometric exercise.[9] The study also showed that the decrease in IOP was directly related to exercise intensity. Furthermore, Qureshi[10] showed that the IOP-lowering effect of exercise was observed not only in normal subjects but also in patients with glaucoma. In fact, the effects are actually magnified in this population. With acute exercise, the post-exercise decrease in IOP is relatively short-lived and lasts between 15 and 60 minutes.

It is more relevant to understand the long-term effects of physical fitness on IOP, as this would have greater clinical impact. Passo *et al*.[11] showed that initiation of exercise training resulted in lowering of baseline IOP by approximately 1.3 mmHg than before training. They also demonstrated this in a group of glaucoma patients where the mean baseline IOP decreased by 4.6 ± 0.4 mmHg after three months of training.[12] It is important to mention that the baseline IOP returned to pretrained levels within three weeks of exercise cessation.[12]

A vascular etiology has often been implicated as contributory to the progression of glaucoma. Studies have shown that retinal blood flow is autoregulated. Hence, though there is an increase in OPP during dynamic exercise, a proportionate increase in the vascular resistance results in only a minor increase in blood flow.[13] The choroid is also autoregulated but to a lesser extent, as choroidal blood flow has been noted to increase in the immediate post-exercise period.[14] However, the autoregulation fails once OPP increases more than 67% above the baseline.[15] Nitric oxide (NO) and endothelin 1 (ET-1) are found to be involved in the regulation of exercise-induced ocular blood flow. Increased ocular blood flow would be of benefit by improving the decreased perfusion that leads to glaucomatous progression. However, the brief increase in ocular blood flow before the autoregulatory return to baseline may not be clinically significant to warrant advocating exercise merely with the goal of modulating ocular blood flow.[16]

Exercise may also induce neuroprotection by upregulating neurotrophin expression, enhancing mitochondrial function, and reducing inflammation. This could be helpful in halting retinal ganglion cell (RGC) loss from glaucomatous damage.[17] Patients with glaucoma are susceptible to anxiety and depression. Studies support the conclusion that exercise is helpful in reducing these symptoms.[18]

Thus, exercise may be a beneficial lifestyle modification and an adjunct in the management of patients with glaucoma. It seems reasonable to encourage patients who have glaucoma to perform light exercises such as walking. However, it is important to remember that this may not hold good for all glaucoma patients. Young adults with advanced glaucoma can experience a vascular steal during exercise, resulting in a temporary loss of vision.[19] Also, in pigmentary glaucoma, it is known that exercise can result in an increase in IOP and should not be recommended. Baskaran *et al*.[20] demonstrated an immediate twofold increase (of around 15 mmHg) in IOP during the period of performing sirsasana (headstand yoga posture). These postures are better avoided in people with glaucoma.

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