Chapter 7
Interactions Between IOP, ICP, OPP

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Intracranial and intraocular pressures are interrelated and relatively independent pressure systems, which keeps themselves in a relatively stable state through aqueous and CSF circulations. These two circulating fluids have many similarities as they both are produced by carbonic anhydrase-catalyzed reactions, generally represent an ultrafiltrate of blood and have nearly identical chemical composition, with more proteins and less ascorbates in CSF. Physiologically ICP and IOP are dynamic parameters, both have circadian variations and similar response to changes in posture, intraabdominal or intrathoracic pressures [1–3]. IOP circadian cycle is quite well known, however circadian pattern of ICP is less clear, suggesting a nocturnal elevation in ICP [4, 5]. The fast changes in IOP and ICP by a probable alteration of intraocular and intracranial blood volumes was also reported [6].

Various studies suggest a correlation between IOP and ICP [7–13]. Experimental study with Rhesus monkeys showed that induced raised ICP caused an increase in IOP, as long as the pressure in the brain was below BP [14]. Another study demonstrated that prostaglandin (E1, E2, A2) infusions induced a decrease in ICP and IOP [15]. Smith et al. found changes in ICP and IOP during induced respiratory acidosis and alkalosis [6]. Sajjadi et al. reported a high correlation between IOP and ICP [16]. Similarly, Lashutka et al. found that IOP correlated with ICP especially in patients with intracranial lesions and without glaucoma [13]. Sheeran et al. also found significant correlation between IOP and ICP, however they concluded that changes in IOP were poor predictors for changes in ICP due to a significant variability in the value of this relation [11]. Other authors hypothesized that this relation breaks down under pathological conditions, when one of the two parameters changes outside the normal range [17]. Contrarily, some studies did not reach statistical significance [18–21]. While Ren et al. found correlation not only between IOP and ICP but also between ICP and BP [7, 22]. One may assume a physiological association

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between IOP, ICP, and BP in a triangular association. In a recent experimental study by Samuels and colleagues, chemical stimulation of the dorsomedial/perifornical hypothalamic region evoked substantial increases in IOP, ICP, BP and TPD in rats. The investigators postulated that the dorsomedial and perifornical hypothalamic neurons may be a key effector pathway for circadian regulation of the autonomic tone by the suprachiasmatic nucleus [23].

In a parallel manner, ICP has been found to be related to BP and higher BP is correlated with higher IOP [22, 24–26]. Population-based studies determined that higher IOP is significantly associated with higher systolic BP and diastolic BP [26–30]. However, epidemiological studies showed incongruous results regarding potential association between BP and OAG: 11 studies found significant relation between OAG and higher BP [28, 29, 31–39], some studies did not reach statistical significance [40–48], while others demonstrated that higher BP was associated with lower prevalence of glaucoma [42–44, 49]. The correlation between decreased BP and OAG risk could be explained by the relationship between ICP and BP. Jonas et al. suggested that reduction of BP has been associated with greater decrease in ICP than in IOP in NTG patients [50]. Siaudvytyte et al. found that lower ICP was correlated with lower diastolic BP in NTG patients [51]. While Ren et al. found this relationship just in healthy controls [22]. The correlation between ICP and BP supports clinical observations that NTG patients tend to have low BP [44, 48, 52]. Others found that higher BP was associated with higher ICP in OHT and healthy subjects and thus might protect against glaucomatous damage in OHT [7].

IOP, OPP, ICP and lamina cribrosa are important parameters in glaucoma pathophysiology and progression. Taking into account the physiological triangular relationship between IOP, ICP and BP, glaucoma might be described as a misbalance between IOP, ICP and BP, leading to increase in TPD and TPG. Further studies are warranted to investigate the involvement of TPG in glaucoma management.

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