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Circadian Rhythm and Cataract Surgery

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Abstract

The circadian rhythm is a complex biologic phenomenon in which environmental light is a major exogenous regulator. Cataract patients' optical system precludes optimal transmission of light, especially the shorter wavelengths that affect the circadian system more. The aim of this article is to provide a general overview of the effect of cataract surgery with different types of intraocular lens in the circadian rhythm. It is consensual in most studies that cataract surgery has a positive impact in circadian rhythm as evaluated by subjective and objective parameters.

Keywords: Actigraphy; Cataract Surgery; Circadian Rhythm; Sleep Quality; UV-blue light filtering intraocular lens

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The circadian rhythm is regulated by melatonin produced by the pineal gland. The afferent tract of this system includes photosensitive Retinal Ganglion Cells (ipRGC) containing melanopsin. These cells are connected to the suprachiasmatic nucleus in hypothalamus via the retinohypothalamic tract. The activation of ipRGC inhibits melatonin production [1, 2]. This circadian pacemaker is regulated by the photoreceptors. However, this system works in the absence of functioning rods and cones and is preserved in a significant percentage of blind people (with no light perception) [3, 4]. Brainard et al. examined the influence of various monochromatic lights on melatonin secretion and revealed peak sensitivity for a wavelength of 447-480 nm (corresponding to the blue spectrum of light) [5]. Normal aging is associated with changes in the transparency of the cornea, lens and vitreous, precluding light transmission. As cataract develops, the human lens becomes a strong light filter, particularly for short wavelengths. Therefore, cataract patients would be expected to have daytime sleepiness because there is not enough short wave length light to reduce melatonin secretion, as well as poor sleep quality during the night. An epidemiological study by Foley et al. on North American population over the age of 65 indicated that 57% of the individuals had at least one chronic symptom of sleep disturbance, 42-43% had problems in falling asleep or in maintaining sleep and 19% woke up too early [6]. Poor sleep quality in the elderly population leads to drowsiness and napping during daytime [7], diminished feeling of wellbeing, impaired cognitive skills [8], increased risk of accident [9] and a potential increase in morbidity and mortality rates [10]. Thus, cataract surgery would provide these patients not only better sight but also greater quality of their sleep, possibly diminishing these unpleasant consequences.

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Several studies reported a significant improvement in sleep quality after cataract surgery. Asplund et al. reported a significant proportion of patients with subjective improvement in their sleep, one and nine months after cataract surgery [11, 12]. This beneficial effect is maintained even with blue-light-blocking Intraocular Lens (IOL) implantation. Published papers concluded that these IOLs do not have a detrimental effect on circadian rhythm, neither did they affect scotopic visual acuity, color vision or contrast sensitivity [13-16].

However, the majority of published studies rely on subjective questionnaires rather than objective data, being susceptible to the placebo effect of cataract surgery. Our work group has recently conducted a study to address this issue at the Neuro-ophthalmology Department of Central Lisbon Hospital Center, in collaboration with the Visual Sciences Research Centre – Faculty of Medicine of Lisbon and the Clinical Electroencephalography and Neurophysiology Centre. The authors studied the effect of cataract surgery in the circadian cycle using both subjective and objective measurements. Sixteen patients with bilateral cataract were randomly selected to undergo bilateral phacoemulsification with either UV-filtering IOL or UV-blue light filtering IOL implantation. Patients were submitted to continuous actigraphic monitoring for 7 consecutive days before and one month after their cataract surgery. Pittsburgh Sleep Quality Index and the Epworth Sleepiness Scale questionnaires were performed before and 1 month after surgery. There was an overall subjective improvement in sleep quality and sleepiness questionnaires. Moreover, the actigraphic records revealed an improvement in circadian rhythm regularity in 37.5% of patients, a reduction in daytime drowsiness in 50% of patients and a reduction in insomnia episodes in 42.5% of patients. An improvement in one or more actigraphic parameters was achieved in 12 out of 16 patients (75%). There were no differences in any of the subjective and objective parameters between patients implanted with UV-filtering IOL and UV-blue light filtering IOL [17, 18].

The circadian pacemaker is a complex and not completely understood system. It is the result of an intricate interaction between endogenous and exogenous stimuli. Visible light, particularly of short wavelength, appears to be an important regulator. Prospective studies to evaluate the effect of visual rehabilitation surgery in the context of unexplained or refractory sleep disorders are warranted. This approach may potentially become an adjunctive therapeutic weapon, even in patients with poor useful vision prognosis.

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