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Introductory Chapter: Why Is Eye Motility Important?

Ivana Mravicic

1. Introduction

Our vision starts with our eyes but the final image that we use in our lives is formed in the brain. Since we have two eyes, we are constantly receiving two different pictures from each eye, respectively. The eyes have to be perfectly tuned together to enable the brain to use two different images and form one three-dimensional picture. The correspondence between the two eyes has to work on several important levels [1].

Correspondence of the two eyes starts at the motor level, which enables the eyes to move in perfect synchrony. Our eyes move with the help of six extraocular muscles: inferior, superior, lateral and medial recti, as well as two oblique muscles named superior and inferior oblique muscles. Because of different insertions of the muscle on the globe, their actions can vary depending on the position of the eye. We can say that the muscles are actually rotating the eye, which results in the possibility of movements in all directions. Muscles are innervated by three cranial nerves (oculomotor, trochlear and abducens). It is impossible to move one eye without the other following. See whether you can do that! When one muscle is innervated, the yoke muscle has the same impulse but in the opposite direction. That synchrony enables our eyes to follow the movement of the other eye.

Perceiving two slightly different images at the same time is called simultaneous perception. When our brain starts to perceive two different pictures as one image, that process is called sensory fusion. To keep sensory fusion working, we need motor fusion that will keep the object in the centre of fovea of each eye. The final ability of the brain is to form one three-dimensional image from two slightly different images that will give us the feeling of depth in space. The final formation of image takes place in the cortex, which plays an important role since more than 50% of cortex is visual cortex [2, 3].

If the synchrony is disrupted, two images are formed in the brain. A disruption can occur at the very beginning in the afferent visual pathway, caused by amblyopia or uncorrected refractive error. In that case, images are too different to be united into one picture. The reason can be in the muscles, caused by inflammation, or autoimmune diseases (Graves' disease) [4]. Muscles are innervated by nerves that travel a long way from their nuclei in the pons and medulla oblongata and are sensitive to traumas of the head or vascular changes. In adult patients, two images result in double vision while, on the other hand, a child's brain has the possibility to adapt and suppress one image, which if not recognised can lead to amblyopia of the suppressed eye.

Children are a very sensitive group of patients and treating kids bears bigger responsibility than treating adult patients because the child's eye is developing, and unrecognised problem or one which is not treated in the right way can cause serious dysfunction of vision, which is sometimes impossible to fix later. The most sensitive

period of visual development is during the first 4 years of life, extending to the age of 7 years. After that age, the sensory system of the brain is formed and improvements are no longer possible [5, 6]. The assessment of children's vision requires special skills, has specific rules and has to be adapted to the age of the child.

Nystagmus is a puzzling, involuntary, rhythmical movement of the eyes. These movements can be caused by some kind of a disruption of the visual development of the child or in the adult age it is often a result of neurological disorders. Our responsibility as ophthalmologists is to recognise which kind of nystagmus is ophthalmological in origin and needs our treatment to encourage visual development. Together with visual aids and some medications, there is some development in new treatments such as biofeedback (making the patients aware of the eye bobbling by sound or touch and, by that, teaching the patient to control nystagmus). On the other hand, neurological nystagmus can be life-threatening and requires urgent neurological examination. Most important signs that have to alarm us to proceed with neurological examination in both children and grown-ups are: the onset of nystagmus after the age of 3 months, oscillopsia (sense of objects moving around us), dissociated and disconjugate nystagmus or associated neurological symptoms (vertigo, nausea, headache, vomiting) [7].

In our work, it is important to be aware of the connection between the eye movement and neurodegenerative diseases since these groups of diseases are becoming more and more common. Neurodegenerative process involves distinct neuron populations in the brain that are involved in circuits of eye movements. The clinical assessment and electrophysiological measurement of the oculomotor function can be useful for understanding the physiopathology and progression of the disease [8].

In conclusion, treating disorders of eye motility is an interesting and demanding process that requires collaboration between different specialities. Ophthalmology and neurology have to work in close collaboration. Another important challenge is treating children whose dynamic of the vision development is very sensitive and specific. Finally, we have a responsibility and the honour to enable and preserve the final perfection of vision which enables us to see the world in different three-dimensional way.

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Author details

Ivana Mravicic

Eye Clinic Svjetlost, Medical School University of Rijeka, Croatia

*Address all correspondence to: ivana.mravicic@svjetlost.hr

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