STRABISMUS

diagnosis and treatment

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Treatment of strabismus and amblyopia is an important yet challenging issue in ophthalmology. The treatment process consists of a difficult diagnosis and therapy in the form of exercises or surgery.

Exercises are aimed at improving visual acuity, convergence, binocular vision function, and enhancing the work of the eyeball muscles. They are carried out in the cases of amblyopia, manifest, latent, and intermittent strabismus, as well as in other visual and locomotor eye disorders.

Diagnostic devices presented in the catalogue: EH-1 Hess Screen and KM-1 Maddox Cross provide valuable services in the area of eye motor disorders, and the methodology of the test has been described in detail.

The aim of the treatment is to achieve binocular vision with the correct setting and the mobility of the eyes. Binocular vision is understood as the vision that is as stereoscopic as possible, with full visual acuity of both eyes and correct, bimacular retinal correspondence. Of course, it is not always possible to achieve this ultimate goal. Treatment should be started as early as possible, even with young children, and must be carried out consistently.

First of all, it is necessary to improve the sight of the visually impaired eye, improve fixation, and visual location using different methods.

MDT offers full range of devices dedicated for strabismus treatment: SW-1 Campbell Vision Stimulator, CH-1 Cheiroscope, AK-1 Convergence Trainer, LA-1 Acoustic Locator, as well as KN-1 Haidinger Phenomenon Coordinator.

Orthoptic exercises cannot replace correction of vision defects or surgical treatment if necessary, but they are an important complement to the treatment process. The exercises are also performed in cases without a strabismus, but before and after surgery.

Exercises are recommended for persons who:
- were diagnosed with strabismus when they were over 2 years old
- have normal visual acuity, the same or almost the same in both eyes
- the refractive error is compensated for by spectacles or contact lenses
- were diagnosed with fusion

A danger of double vision occurs if orthoptical exercises are used in patients with insufficient fusion. In addition, a contraction of the accommodation can sometimes occur due to excessive convergence exercises.

Therefore, the exercises should be carried out only by specialists who have the competencies to perform this kind of treatment.

A wide variety of devices are being used to improve binocular vision functions. However, the choice of treatment method and devices should be made according to the patient's case and individual abilities.

We hope that the treatment with MDT devices will be effective and meet the objectives set.

Dr Halina Bryg and MDT team

Diagnosis in strabismus disease

Treatment in strabismus disease

KM-1 Maddox Cross

Diagnostics in strabismus disease

Maddox tangent graduation has been used to diagnose strabismus and other eye disorders.

Use of the graduation of Maddox tangents allows diagnose:

1) latent strabismus with the use of the Maddox rods
2) the size of the objective angle in manifest strabismus
3) gamma angle
4) retinal correspondence

Description

The scale of tangents is cross-shaped, sometimes its vertical arms are shorter. There's a small white light at the zero point in the centre of the cross. The horizontal arm of the cross usually should be approx. 1 m long, which allows to test eye deviations up to 10° at a test distance of 5 m, and up to 25° at a distance of 2 meters. The arms of the cross have graduation marked with numbers.

The individual spacing of the graduations correspond to the arched degrees. The larger one is used for the distance of 5 m, and the smaller one for the distance of 1 m.

If it's required to express the graduation in prismatic dioptres (prdptr), you must remember that the shift of the image on the graduation by 1 cm from the distance of 1 m corresponds to 1 prdptr. Thus, from the distance of 5 m image shift of 5 cm will correspond to 1 prdptr.

Ad 1) Examination of the latent strabismus (heterophoria)

Please use the graduation of Maddox tangents and Maddox rod (a dark red glass with red glass stripes stuck on it).

While looking through such glass at the white light point, one sees a red line running perpendicularly to the stamens, and always on the side opposite to the deviation of the eye.

The test should be carried out in a darkened room at a distance of 5 m. The patient shall fix the light at the centre of the tangent graduation. The rod should be placed in front of one eye (conventionally in front of the right eye). The rod is a kind of dissociation, because the patient sees a red line with one eye, and a white light with the other eye.

If the horizontal deviations are examined, the stripes in the Maddox rod must also be set horizontally (in front of OD/RE), then the red line will be formed perpendicularly to the stripes, so it will be vertical.

When testing vertical deviations (hyper or hypophoria), we place a rod with vertical stripes in front of the right eye. A red horizontal line will occur.

Sometimes the red line is at an oblique position, which indicates cyclophoria.

When the eye turns inwards, the red line is tilted outwards (incyclophoria).

When the eye turns outward, the red line is tilted inward (excyclophoria).

In a person with normal orthophoria, the red line passes exactly through the white light.

If the patients sees the red line temporally from the light (uncrossed position), it indicates a convergence (esophoria, endophoria). When the examined person sees a red line on the opposite side of the lamp (crossed position) the exophoria is indicated. If it is above the light, it means that the eye is lower (hypophoria), if under the light then the eye is tilted upwards (hyperphoria). The above rules of setting the Maddox rod make it easier to select prisms.

Heterophoria is a common phenomenon and accounts for about 59% of the cases.

Ad 2) Measurement of the objective angle of a strabismus (manifest strabismus)

Measurements should be performed at the distance of 1 m. There are 2 ways:

#1 - fixation of the healthy eye (leading eye) in the light on the tangent scale.

In the strabismus eye, the light reflection will be located peripherally.

The examiner moves the pencil or the marker along the graduation (to the left or right of the light depending on the type of strabismus) until the reflection in the patient's eye is centrally located.

The number on which the marker is placed is the size of the angle of the strabismus. This method is used to test the angle of strabismus mainly with eccentric fixation.

In this way, the angle of the primary and secondary strabismus in paralytic strabismus can also be examined.

In these cases, the size of the deviation can be examined in different directions by instructing the patient to turn his/her head to the right or to the left and fix the light with the healthy eye at the same time.

#2- variable fixation method, the patient looks alternately at the light, and at the indicator moved on the graduation. It is recommended that the patient fixes alternately until the adjustable eye movements stop.

The moment of cessation of adjustable movements is determined by the indicator on the graduation by the value of the strabismus angle.

This method is used in cases with central fixation (usually in alternating strabismus).

Ad 3) Gamma angle testing

The deviation between the axis (line) of vision and the optical axis of the eye is called the gamma angle.

Physiologically, it is approximately 1°. When it is larger, it can look like a strabismus.

If the reflection of the light is nasally from the centre of the pupil, the gamma angle is negative (the line of vision is located temporally from the centre of the pupil and it looks like a convergent strabismus).

If the reflection is closer to the temple, the angle of the gamma is positive (the line of vision is located nasally from the centere of the pupil) and appears to be divergent.

Examination

The patient is sitting at a distance of 1 m from Maddox graduation. The examination is performed for each eye separately, with the other eye covered completely.

The examined eye is positioned in front of the light, which is fixed by the patient. We assess the position of the reflection of light in the examined eye. If the light reflection is in the middle of the pupil, there is no gamma angle (0°). If it is not in the middle, gamma angle occurs. A pencil or marker is moved along the graduation in the right direction to obtain a reflection in the middle of the cornea. This moment is a measure of the gamma angle.

Note!

When measuring the objective angle in the manifest strabismus, it is also necessary to examine whether gamma angle occurs. The gamma angle is important for the qualification for surgery, especially in a case of large angle strabismus.

Ad 4) Determination of retinal correspondence

One of the many methods of determining retinal correspondence is the Cüppers method with the use of a Maddox cross and a visuscope.

The patient sits sideways in front of the Maddox graduation from a distance of 1 m and fixes the light with the healthy eye through an oblique mirror. This is to set the eye better in the strabismus, so that the worse eye will be straight, which will make it easier for us to project the star of the visuscope onto the middle fovea of the eye. Patient's positioning of the star on the Maddox scale indicates the angle of the anomaly taking into account the test distance.

If the star is visible in the light, the retinal correspondence is correct.

It is not always possible to measure the anomaly angle accurately and precisely. Retinal correspondence is variable and difficult to determine, especially in children.

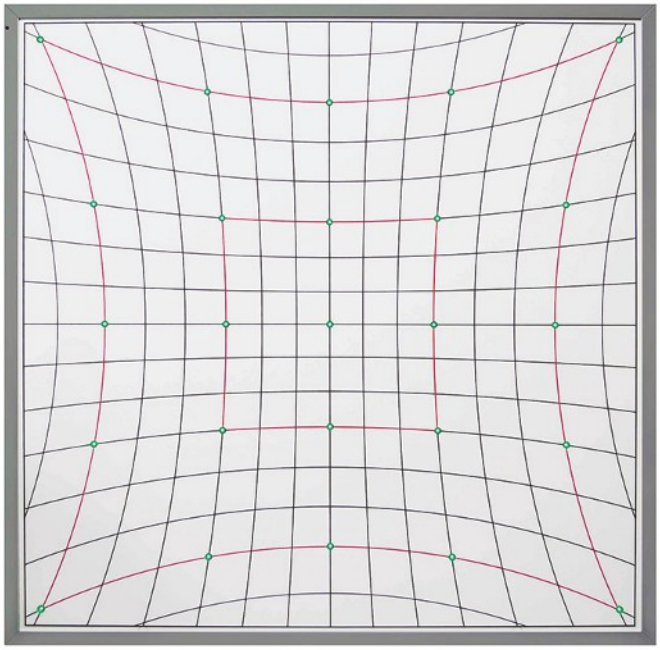
Note!

For all these tests, it is advisable to use a chin support to achieve a stable head position during the tests. This prevents unnecessary movement of the head and the result is more accurate.

Guidelines developed by Dr Halina Bryg

EH-1 Hess Screen

eye muscle coordinometry testing



The test shall be based on the detection of a false location for the action of the paralysed muscle.

The test is most commonly used in paralytic strabismus and muscle paralysis and paresis;

In practice, 3 types of screens are used:

1. the points on the screen are grey and then we need to have two flashlights (red and green) and red and green glasses.

2. the points on the screen are green and then we need to have one red flashlight and red and green glasses.

3. the points on the screen are red and then we need to have one green flashlight and red and green glasses.

The colour placed on the screen has no significance and does not affect the test results even in small children.

If we use the screen No. 2, when the right eye is examined, the patient has a red filter in front of the right eye and a red flashlight in the hand, and a green filter in front of the left eye.

We subsequently turn on all points (green) in a small field and then in a large one and the patient covers them with a red pint from the flashlight.

Each point is marked with “x” on the chart. We connect the recorded positions with each other, using straight lines that form a field (small and large). If the positions indicated by the examined person coincide with the position of green points on the screen in all 9 directions of the vision, then there are no muscular disorders. If the disorders exist, then the analysis of the charts shows that the eye with the abnormally functioning muscle is the one whose chart of motions is smaller according to the principle that the primary deviation is smaller than the secondary deviation.

Then, in order to examine the movements of the left eye, the glasses should be changed so that the red filter is in front of the left eye and patient holds the red flashlight in hand. The test shall be the same as for the right eye. The chart of the second eye shows secondary hyperactivity of the auxiliary muscle to the damaged muscle in the patient’s eye.

The patient sits at a distance of 1 m from the screen so that his/her eyes are exactly in front of the central screen light, with the head on a chin rest.

To record the results of the test, two charts are used for each eye separately, showing a reduced copy of the grid on the screen.

Guidelines developed by Dr Halina Bryg

KN-1 Eye Coordinator

treatment of amblyopia

The device consists of a housing and a forehead support. A patient leans the forehead and observes through the magnifying glass the Haidinger phenomenon used in this device.

To be effective, exercises should be performed with an active patient, often with a child drawing or outlining the contours of the pictures on a transparent glass plate with a thin dry erasable marker only in black colour. We define these exercises as active. However, often, exercises with a use of the Haidinger phenomenon are performed passively, i.e. the patient only observes the Haidinger phenomenon and tries to keep it in the centre of the picture.

The exercise set includes three black glass pictures (plates) with a light transparent field in the middle and a fixation picture. These fields are of different sizes: large, medium and small.

Instead of plates, some devices use a concentric diaphragm similar to those applied in a camera. In this case, the diaphragm width is adjusted to obtain the width of the area of view.

KN-1 is one of the devices used in the Cüpper method for treatment of amblyopia, but it can also be used in conjunction with other devices (combined exercise).

Exercise

Exercises with Haidinger phenomenon are based at the first stage on observing (fixing) the rotating propeller ("fan"). Initially it is seen from the side, similarly as an euthyscopic afterimage (usually in eccentric fixation). The patient should be systematically suggested to try to keep the propeller in the middle of the picture. There's always a small circle in this picture that marks the centre of view. In this way it is possible to coordinate the Haidinger phenomenon with the real object (hence the name of the device).

With this exercise we try to get the correct location "straight ahead".

In the next stage we practice the motor coordination between the hand and the eye. For this purpose, we use the plates limiting the vision area or the concentric diaphragm. The limitation of the area is strictly dependent on the type of fixation examined in the visually impaired eye. The better the fixation and the closer the fovea, the narrower the area of vision should be.

The patient can point the centre of the image with an indicator and thus more easily recognize the Haidinger phenomenon in the right place.

It is also possible to induce an euthyscopic afterimage and observe the Haidinger phenomenon simultaneously. They happen to be visible in different places. We prevent this through narrowing the field with appropriate diaphragms. If the patient does not see the propeller, the attempt should be repeated several times, changing the rotation intensity of the propeller, combined with euthyscopic afterimages to remove the braking processes. Exercises are performed with the healthy eye covered and in a darkened room. A child must exercise under constant supervision of a certified orthoptician only. An exercise lasts 15-20 minutes, depending on the patient's ability to concentrate.

Operating principle

The coordinator uses the Haidinger phenomenon, which is seen only with the macula, as it depends on its anatomical structure. The macula contains a yellow pigment, and a radial system of retinal fibers, which allow to perceive this phenomenon. The construction of the device is based on the fact that looking through a polarizing filter at a uniform bright surface, we notice as if a propeller or a bunch of them were forming a blurred, dark cross. The phenomenon is more visible when a dark blue filter is applied. As the polarization filter rotates, the Haidinger phenomenon rotates too, giving the impression of a rotating aircraft propeller.

If the patient sees the phenomenon, it is a proof that he/she is looking at with the macula. The level of visual acuity is irrelevant, because even people with cataracts recognize the phenomenon.

The aim of the exercises on the coordinator is to fix or obtain a central fixation and practice the correct macula location together with the coordination of eye and hand, which at the same time improves vision.

Indications:

Treatment on the coordinator should be used in the case of monocular amblyopia. The degree of visual impairment is irrelevant. However, the type of fixation with a viscoscope should be precisely defined with visuscope, as the existence of eccentric fixation may determine the way of conducting exercises with the use of this device. It is also necessary to check whether the child recognizes the euthyscopic afterimage and Haidinger phenomenon at the same time.

The exercises with the KN-1 coordinator can be combined with the Campbell method, obstruction, locator exercises, targeting exercises performed at home, and the afterimage method with the use of an euthyscope. The exercises can be performed from the age of 3 years. The treatment of cases of visual impairment with central fixation promise good results.

Contraindications:

Exercises with the coordinator should be performed with special caution in case of eccentric fixation, especially in children over 6 years of age. No contraindications to the Haidinger phenomenon are known in these cases, but it is only recommended to carry out these exercises skilfully in order to normalize the retina in a proper way and regain the macular, main direction of view.

Follow the recommendations described above.

In a case of very deep vision impairment and failure to recognise the Haidinger phenomenon, the first step is to increase the number of afterimages caused by the euthyscope, and to perform targeting exercises on a white screen. However, in a case of vision impairment with central fixation we do not need to use an euthyscope.

In young children, 3-4 years old, exercises may be performed in two stages, e.g. 2 times for 10 minutes each, with breaks to practice with other devices. In these cases, better results can be achieved by including the SW-1 Campbell Stimulator into these exercises.

Guidelines developed by Dr Halina Bryg

SW-1 View Stimulator

according to Campbell

The device consists of a metal housing made in such a way that the surface to be used for exercises is placed above the table top, in front of the child's eyes.

The exercise surface has a white background and a round test with large stripes of high contrast (black and white) placed on it.

A transparent board (glass) is placed above the round test.

The set should include 6-7 round tests with stripes, a dry removable marker and a set of slides (pictures on an additional glass or foil). These slides can be placed under the main glass so that the child can precisely outline the contours of the picture placed on the foil. During this time, the round test with the stripes rotates very slowly.

Exercise

The healthy eye should be carefully covered during the exercise. The test with stripes should be selected depending on the level of visual acuity of the patient. In the case of severe visual impairment, exercise should be performed with the widest stripes (test #1).

The exercise time must not exceed 7 minutes. After 2-3 minutes it is possible to change the test to slightly narrower stripes, e.g. test #2. Some authors point to the
possibility of changing the stripes every 1 minute from the widest to the narrowest, i.e. to use all the tests in one exercise.

We should choose one of the above options, but the child should be able to see clearly the test stripes that we want to apply. We can confirm our choice with a PL (preferential looking) method if possible.

During the exercise, the child will observe the stripes rotating very slowly and at the same time, the patient will make different drawings on the glass or outline the contours of the foil.

This makes it easier to focus attention on the stripes and trains the eye-hand location at the same time.

As the vision improves, we should reduce the width of the stripes during the exercise.

The child must be under constant supervision of the orthoptician.

Before the exercise, the patient should be explained and shown how to do it properly.

The exercises with SW-1 View Stimulator are combined with other devices (methods).

The procedures are repeated every day in series (1 series - 10 exercises). There are no rigid and simple rules about the time between sessions, but 2-week treatments are most commonly used, and they are followed by a break of about 1 month depending on the degree of visual impairment, results after exercise, also after consultation with the attending physician.

Operating principle

Treatment of amblyopia with SW-1 CAM stimulator is based on the assumption of active, controlled stimulation of the patient's eye. Rotating stripes are simple stimulating the retina in spatial and localisation terms.

Studies show that the cells in the cerebral cortex responsible for seeing images respond best to moving lines of a certain width. This device is designed to activate the cells in the cerebral cortex and, at the same time, the entire visual system.

Indications

In some cases, there are rapid improvements in vision and therefore it is necessary to observe the diagnostic standards before exercise, and evaluate the effects of the therapy in order to avoid persistent diplopia. It is necessary to examine the distant and near acuity very carefully, note if there is a disturbance in the recognition of densely arranged signs and to what extent, examine the angle of strabismus, retinal correspondence, perform stereoscopic tests, check the presence of fusion, determine the type of fixation and evaluate the type of vision deficiency (strabismus, anisometric, without strabismus, caused by fixation disorder, congenital).

Campbell treatment can be started in 2,5-3 year old children, although different exceptions may occur. Exercise for 7 minutes may replace all-day obstruction. In cases of persistent visual impairment or treatment for a longer period of time and with slight improvement, it is recommended to combine this method with obstruction or a reducer of visual acuity, pleoptical and targeting exercises performed at home.

The combination of these methods accelerates the treatment and brings good results.

Contraindications

This method should not be used in cases where obstruction treatment is contraindicated. The greatest caution should be exercised in children over 8 years of age, mainly in the case of eccentric fixation. In this case we should include the pleoptic exercises and carefully control the type of fixation once a week. The exercises with the SW-1 Campbell stimulator support the process of treatment of vision impairment and improve its results also in these difficult cases.

Note!

SW-1 View Stimulator must not be shared with, or rented out to the parents of the treated children.

Guidelines developed by Dr Halina Bryg

LA-1 Acoustic Locator

Improving the function of binocular vision

The acoustic locator consists of a board, placed on an inclined table top which is an angle of 30° with the table surface. The board contains gaps in the shape of letters, numbers, pictures or other elements, which can be arranged in 3 separate patterns, or one uniform pattern (depending on the locator model). If there are 3 separate patterns, each one is adjusted to the degree of amblyopia. The metal board and the stylus - the patient is holding in his/her hand - form a closed electrical circuit.

Exercise

Before starting the exercise, we should carefully check patient's near and distant vision acuity in the correction. During the exercise it is necessary for the orthoptician to control and supervise the proper performance by the child.

The patient has the healthy eye covered and using the stylus he/she is supposed to outline a gap of appropriate width and shape. If the patient makes a mistake and goes beyond the insulated groove with the stylus, the circuit will be closed and a signal will be heard. This is proof that the child has made a mistake, and this controlled signal allows the child to correct the visual it. The aim of the exercises is to improve visual acuity, enhance central fixation, and exercise the correct visual location of the eye and hand.

Indications:

Exercises on the acoustic locator can be performed even by small children aged 3-4 years. The exercise should last about 5-10 minutes depending on the child's attention and concentration. Exercises on the acoustic locator are especially recommended in case of central fixation and unstable central fixation in amblyopia. The exercises are used in the Cüppers method and in other combined methods of treating visual impairment.

Note!

The acoustic locator can be modified by changing the width of the gap (changing the board). Then we choose a board with a sufficiently wide gap, e.g. a wide gap in severe amblyopia, average in medium amblyopia, small gap in slight amblopia. The child can exercise on one board or on 3 boards in one exercise.

Guidelines developed by Dr Halina Bryg

CH-1 Cheiroscope

improvement of binocular vision functions

A cheiroscope is a device used to practice the function of binocular vision. CH-1 is built in such a way that each eye sees a different image. A patient leans the forehead and looks thru convex lenses. One eye looks at the oblique mirror, and the other at a sheet of paper placed on the base of the device. Convex lenses create the conditions for looking in the distance, because the pictures are lying in the focus of the lens. Distance between device surface and the eyes is about 30 cm. The device is suitable for left- and right-handed children.

Exercise

The patient rests the forehead on the support and looks through the convex lenses. The side handle contains a simple picture, preferably the outlines of objects, drawn with a thick, black line, e.g. a house, a tree, etc. A sheet of white paper is placed on the base of the device. As the exercise is difficult, we use simple pictures. The patient's task is to redraw the picture onto a piece of paper, exactly on its contours. A picture fixed with a leading eye or a line drawn with an eye with strabismus or a pencil fixed with that eye often disappear. At this point, the patient must blink several times, which counteracts fatigue and allows to continue exercising.

Operating principle

The exercise should be performed under the supervision of a certified orthoptician.

The patient fixes a picture reflected in a mirror with one eye, and looks at a piece of paper with another eye and outlines exactly the contours of a picture that is "mentally" projected onto a paper.

The patient, in whom the cooperation of both eyes has only recently been developed, is unable to make an accurate drawing, because it is difficult to see the comparing a model image with a drawing of the patient. If the drawing is larger or smaller than the original, this means alternate viewing. In order to compensate for the strabismus angle, prisms can be used for exercises. The power of the prism should be appropriate to the angle of the strabismus. Exercises with CH-1 Cheiroscope stimulate binocular vision, and where incomplete binocular vision occurs, they fix it and allow for a better range of depth vision.

We control the results using a synoptophore and tests for stereoscopic vision by evaluating the recognition in angular seconds.

Indications and contraindications

Cheiroscope exercise is a re-educational exercise where the aim is to improve binocular vision. The exercises are used in latent strabismus, in a slight manifest strabismus, in intermittent strabismus, in binocular vision dysfunction.

The condition for starting exercise is good visual acuity in both eyes not lower than 0.8 in the weaker eye and the appropriate maturity of the patient. In patients with suppression and correct retinal correspondence, these exercises are designed to overcome suppression and stimulate binocular vision.

Exercises should not be performed in patients with a history of lack of fusion, and in patients with large angles.

Practical guidelines developed by Dr Halina Bryg

AK-1 Convergence Trainer

Improving convergence

Convergence is a symmetrical motion converging both eyeballs.

A deficiency of convergence occurs not only in cases of exophoria and divergent strabismus, but also sometimes in convergent strabismus, especially alternating strabismus.

It should be remembered that in addition to the examination of eye movements, the convergence should also be tested. The normal value of the near point of convergence in children is about 50-60 mm. The measurement should be
made from a line joining the rotation centres of both eyes, which lies 25 mm beyond the base of the nose. Therefore, 25 mm is added to the usual distance of 30-40 mm.

The main stimuli for convergence are accommodation and fusion. The complete convergence consists of accommodation, fusion, tonic and psychological convergence. The test of the near point of convergence is the examination of the complete convergence.

Convergence deficiency is quite common and many factors influence its origin: phylogenetically late development of convergence, large pupil distance, refractive defects, failure to use accommodation and convergence (e.g. in myopia not compensated for by glasses), old-age myopia, undersight and lack of binocular vision, mental disorders, metabolic disorders, endocrine disorders, paresis of straight medial muscles.

Symptoms of convergence deficiency such as: double vision, headaches, eye pains occur in different intensity. Sometimes they become visible after prolonged work at close range. The near point of convergence in children and adolescents should coincide with the near point of accommodation. In a convergence deficit, the near point of convergence is clearly distant from the near point of convergence.

Convergence exercises are carried out before and after the surgical procedure. Before surgery, exercises are used to enhance convergence (which may also be weak in convergent strabismus) to prevent secondary deficiency after surgery. Sometimes convergence exercises are used as a supplement to orthoptic exercises, in cases which do not require surgery, e.g. in convergence deficiency, severe exophoria, intermittent divergent strabismus. Exercises can be carried out in a simple way, i.e. slowly bringing a small object closer to the patient's eyes and observing the convergence movement.

However, the most effective are the convergence exercises with use of a special device according to the idea of Bangerter, the so-called "helix". It provides a strong stimulus for convergence, also in cases with poor or undeveloped fusion. The use of a rotating spiral makes it easier to focus attention on its central point.

The patient moves the spiral on the rail slowly towards the eyes and puts some effort into it because some resistance must be overcome.

The duration of the exercise ranges from 5 to 15 minutes and depends on the age of the child, the type of surgery and the condition of convergence. We can take short breaks during the exercise. The orthoptist should keep an eye on the child and control the exercise at all times.

Note!

If orthoptic exercises are used in patients with insufficient motor fusion, a risk of double vision may occur. In addition, the accommodation contraction can sometimes appear due to excessive convergence exercises or too intensive control of the divergent strabismus with a large angle.

Guidelines developed by Dr Halina Bryg

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