Srabismus, Squint, Crossed Eyes
The principles of the pathogenesis and that of the treatment of accommodative, convergent strabismus was discovered and developed by a former chairman of our Department, Professor Kettesy.
Binocular Vision

- Horopter: is a circle that connects the target point (F) and the optical center of the two eyes.

- Points on the horopter will fall on corresponding retinal areas (F'). This makes the fusion of the two images in the visual cortex possible.

- Points inside and outside the horopter (A and B) fall on disparat retinal areas (A' and B'). The fusion of these image points is not possible.
We think of strabismus if one of the eyes of the patient turns nasally or temporally, that can be best evaluated by comparing the position of the light reflexes on the two corneas.
Estimation of the objective angle of strabismus based on the position of the light reflex on the cornea of the squinting eye.

The more the light reflex is shifted from the center of the cornea the higher the angle of strabismus.
If the light reflex on both eyes is shifted from the center symmetrically, this is pseudostrabismus.

This occurs in patients whose anatomical axis and visual axis do not point in the same direction.
Measurement of the primary angle of strabismus using a perimeter

The dominant (non-squinting) eyes is fixating the center of the sphere. The light source is moved until the light reflex will fall in the center of the cornea of the squinting eye.
How does uncorrected hypermetropia lead to the development of accommodative, convergent strabismus?

<table>
<thead>
<tr>
<th></th>
<th>Infinity ( &gt; 5 m)</th>
<th>Reading distance 33 cm (1/3 m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emmetropia</td>
<td>0 D</td>
<td>3 D</td>
</tr>
<tr>
<td>Hypermetropia without correct.</td>
<td>pl. 2 D</td>
<td>if 2 D to distance then 2+3=5 D</td>
</tr>
<tr>
<td>Hypermetropia with correct.</td>
<td>0 D</td>
<td>3 D</td>
</tr>
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</table>
To a target point at 33 cm 3 D accommodation and $11^\circ$ convergence is needed.

Greater accommodation (5 D) is accompanied by greater convergence ($14^\circ$). The brain reacts, as if the target would be closer (at 25 cm instead of 33 cm).
The patient, to avoid diplopy, will look at the target with one eye.

The unnecessarily high convergence caused by higher accommodation will remain. The other eye will turn in (nasally).
If the patient’s hypermetropia is corrected with glasses, the higher accommodation disappears, there is no longer need for greater convergence. The other eye will not squint.
Strabismus shows family accumulation (increased occurrence)

The refraction of the eye (and also hypermetropia and axial length that determine refraction), are inherited in a polygenic (multifactorial) way.
The maximal visual capacity of the retina decreases at a growing distance from the foveola.

In the foveola centralis 1,0 (100%), at the edge of the macula 0,1(10%), far from the macula only 0,01-0,02 (1-2%).
This is the reason why amblyopy will develop on the squinting eye.

We project a star with the ophthalmoscope into the eye of the patient and ask him to fixate it. The position of the star on the retina will indicate the point of fixation.
The correction of amblyopy with occlusion

- The dominant (non-squinting) eye has to be covered.
- In this way we force the child to use the amblyopic eye, the visual acuity on the bad eye will improve.
- The point of fixation will gradually be shifted back to the foveola.
- The vision will parallelly increase.
- Amblyopy will disappear.
The cover test is the basic examination method in strabismus.

We cover one eye of the child, and observe the correction movements when the covering is removed.
By covering we break the fusion, the covered eye will start to squint, latent strabismus will become manifest.

On removing the covering the converging eye will move outward, the diverging eye will move inward.
Determination of the angle of strabismus, differentiation of various types of strabismus is done with the synoptophor.
Two images are projected into the two eyes of the patient through two oculars (eyepieces), the angle of projection can be changed on the two sides separately.

If fusion is present at the beginning, there is no squint. If there is no fusion, we move one ocular till the two images coincide i.e. fusion is achieved.
Another objective method for the examination of strabismus is the Maddox test. A large cross is on the wall, with scales on it, in 5 m distance from the patient. A prism is put in front of one eye of the patient, that distorts the fixation point into a line. The patient will see the cross with one eye and the line with the other. The position of the line related to the point of fixation will show the type and the angle of strabismus.

Esophoria is the English name of convergent strabismus, exophoria is the English name of divergent strabismus.

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Very similar examinations can be performed using different images projected to the retinas of the patient.
A special method for the objective determination of the refraction of the eye is skiascopy. Light is projected to the eye of the patient through different lenses in the sciascopic rod. If we move the light source horizontally and change the lenses in the rod, the direction of the movement of the shadow will change at the distal focal point of the eye, from which the refraction of the eye can be deduced. The test is done in Atropin cycloplegia.

Skiascopic rod, with + and – lenses

The horizontal movement, in two directions, of the shadow, in the patient’s pupil, during the examination ("shadow test").

Light is projected to the eye of the patient through different lenses in the sciascopic rod. If we move the light source horizontally and change the lenses in the rod, the direction of the movement of the shadow will change at the distal focal point of the eye, from which the refraction of the eye can be deduced. The test is done in Atropin cycloplegia.
If we ask the patient to look into different directions, the angle of strabismus will be different. This is an important sign with the help of which paralytic strabismus can be differentiated from accommodative strabismus!
The position of the straight and the oblique outer eye muscles on the anterior and on the posterior aspects of the eyeball
The effects of the external rectus and oblique eye muscles on the movements of the eyeball

The function of the eye muscles – the Marques’s scheme
The analysis of paralytic strabismus at different directions of gaze.

<table>
<thead>
<tr>
<th></th>
<th>Right gaze</th>
<th>Straight ahead</th>
<th>Left gaze</th>
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<tbody>
<tr>
<td><strong>Upward</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Superior rectus</td>
<td><img src="image" alt="Eye" /></td>
<td><img src="image" alt="Eye" /></td>
<td><img src="image" alt="Eye" /></td>
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<tr>
<td>Inferior oblique</td>
<td><img src="image" alt="Eye" /></td>
<td><img src="image" alt="Eye" /></td>
<td><img src="image" alt="Eye" /></td>
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<tr>
<td><strong>Lateral rectus</strong></td>
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<tr>
<td>Medial rectus</td>
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<tr>
<td><strong>Downward</strong></td>
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<td>Inferior rectus</td>
<td><img src="image" alt="Eye" /></td>
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Relative accommodation capacity

Schematic model of the relative accommodation capacity (a demonstration of Kettesy’s theory for the development of accommodative strabismus).
Kettesy’s diagramm

Donder’s diagram corrected and further developed by Kettesy.
Professor Kettesy was working on his strabismus theory in a certain period of his life. This period is between the publication of two papers, both appeared in "Orvosi Hetilap" (The Hungarian Journal of General Medicine).

An invited paper by the editorial board of the Journal published in 1959-ben on the occasion of the 100th anniversary of the Journal

A paper published in 1974 on the occasion of the 25th anniversary of the resatrating of the Journal after the second World War.
Between 1959 and 1974 he published 10 papers, among them his 100th paper, in international journals, in which he described in details his theory concerning the pathomechanism, the diagnosis and the therapy of accommodative convergent strabismus.

The 2nd trias of Donders:
1. fakultative hypermetropie,
2. relative hypermetropie and
3. absolute hypemetropie
and thier role in the development of accommodation strabismus.
Kettesy showed, that the relation between accommodation and convergence can be better described by a parallelogram than by a curves of Donders.

Kettesy proved, that in hypermetropias with different degree, not the size or shape of the parallelogram, rather its position, related to the origo, is different. This was a discovery of fundamental importance!
Fakultatív hypermetropy does not cause strabismus even without correction. Relatív hypermetropy always leads to the development of convergent strabismus. By prescription of proper glasses in time this can be prevented (1).

Corrected hypermetropy.

Relatíve hypermetropy.

Facultatív hypermetropy

Absolute hypermetropy

Absolute hypermetropy has to be corrected to improve vision, not because of the danger of strabismus (2). Weaker glasses than necessary turn facultative hypermetropy into relative hypermetropy causing manifest strabismus therefore has to be avoided (3).
Facultative hypermetropy does not cause strabismus even without correction. Relatív hypermetropy always leads to the development of convergent strabismus. By prescription of proper glasses, in time, this can be prevented (1).

Absolute hypermetropy has to be corrected to improve vision, not because of the danger of strabismus (2). Weaker glasses than necessary turn facultative hypermetropy into relative hypermetropy causing manifest strabismus therefore has to be avoided (3).
The statue of Professor Kettesy

created by the sculptor Sándor Györffy.