Horizontal Transposition of the Vertical Rectus Muscles for Treatment of Ocular Torticollis

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ABSTRACT

In most instances, a head tilt to either shoulder is caused by hypertropia or cycloptropia and responds well to conventional surgical strengthening or weakening operations on the cyclovertical muscles. Occasionally, an ocular head tilt occurs in the absence of cyclovertical strabismus, in association with congenital nystagmus or without an apparent cause. We have successfully treated four of five such patients by surgically rotating the eye(s) around the sagittal axis. This was accomplished by horizontal transposition of the vertical rectus muscles. No complications were encountered. We present this method as a viable alternative to other surgical approaches to rotate the eyes around their sagittal axis.

INTRODUCTION

Cyclovertical strabismus may cause a compensatory head tilt toward the right or left shoulder. In most instances, the purpose of the head tilt is to permit fusion in the presence of a cyclovertical muscle imbalance. Less frequently, and when fusion cannot be maintained, the head is tilted to separate the double images as far as possible. As a rule, surgical correction of the hypertropia or cycloptropia restores fusion and normalizes the head posture. Occasionally, a patient will tilt the head without an underlying cyclovertical muscle imbalance. The head tilt may disappear upon patching one eye and is, therefore, of ocular origin. It occurs in patients with congenital manifest nystagmus or without any apparent cause as part of the infantile esotropia syndrome. For treatment of the head tilt in such cases, Conrad and de Decker suggested to apply the guidelines by Kestenbaum and Adeleit and Cüppers for nystagmus surgery on the horizontal muscles. According to this principle, the eyes are moved surgically into the direction of the head tilt. For instance, in the case of a head tilt to the right shoulder, the eyes are rotated to the right around their sagittal axis by surgically producing exycloduction of the right and incycloduction of the left eye. This can be accomplished by advancing or recessing the insertions of the oblique muscles by vertically displacing the horizontal rectus muscles or, according to Spielmann, by slanting the insertions of all horizontal rectus muscles.

In a previous report, we have shown that cycloduction also may be produced by horizontally displacing the vertical rectus muscles. We have applied this method to the treatment of ocular head tilt unrelated to cyclovertical muscle imbalance in five patients.

METHOD

The surgical principle is illustrated in Figure 1, using the right (A) and left (B) eyes of a patient with a head tilt to the right shoulder as an example. Horizontal transposition of the vertical rectus muscles rotates the eyes into the direction of the head turn by causing exycloduction of the right eye and incycloduction of the left eye. The muscles were transposed one full muscle width, and the nasal and temporal aspects of the tendon were reinserted at the same distance from the limbus as was measured prior to their disinsertion.

Eye movements were recorded quantitatively in case 3, using digitally sampled electro-oculography with seven Beckman electrodes placed monocularly around each eye. One set of electrodes was placed vertically over the left eye. The signal was recorded onto a four-channel Grass polygraph. Curved linear paper was used to record the electro-oculogram at a chart speed of 10 mm per second. Fixation at 1 meter was maintained using an accommodative target of a small picture equivalent to a visual acuity of approximately 20/40.
CASE REPORTS

Case 1. A 9-year-old boy presented with a history of "jerky" eyes since early infancy. He had a head tilt to the right shoulder measured to be 28° (Fig 2A) with a torticollimeter (Fig 3). Corrected visual acuity with both eyes was 20/40 with the head tilted, 20/20 with the head passively straightened, and 20/200 with the head tilted to the left shoulder. He had a refractive error of +5.50 diopters sphere in the right and of +6.00 D sphere in the left eye. A manifest jerk nystagmus was present and noted to decrease when the head was tilted to the right. The patient was orthotropic at near and distance fixation and stereopsis was 120 seconds of arc on the TNO random dot test. The remainder of the eye examination was normal. Because of the patient's complaints about neck strain, surgery was advised.

To rotate the eyes around their sagittal axis in the direction of the head tilt, we transposed the right superior rectus tendon nasally and the right inferior rectus tendon temporally, the left superior rectus tendon temporally and the left inferior rectus muscle nasally one muscle width (Fig 1). Care was taken in this and other patients operated on in this manner to reinsert the nasal and temporal aspects of the tendon at the same distance from the limbus as was measured prior to their disinsertion. Postoperatively, the head tilt was no longer present (Fig 2B), and visual acuity was 20/40 with both eyes open and the head in a normal position. The patient had remained orthotropic. Postoperatively, the fundus of the right eye showed exotropia (Fig 4A), and that of the left eye incyclotropia (Fig 4B). The patient was unaware of subjective tilting of his environment. The head posture was still normal when the patient was last examined 15 months after surgery.

Case 2. An 8-year-old boy presented with a history of having had esotropia since early infancy for which a recession of both medial rectus and inferior oblique muscles had been performed elsewhere. On examination, he had a head tilt to the right shoulder (Fig 5A) which we determined to be 25° by torticollimetry. The patient showed a strong fixation preference for the right eye. Visual acuity of the right eye was 20/20 without correction with the head tilted to the right and remained the same with the head passively straightened. The left eye was amblyopic and had a visual acuity of 20/100 regardless of the head position. The refraction was plano in the right and +2.00 D sphere in the left eye. In spite of the equality of the visual acuity with and without the head tilt, the patient reported that he could “see better” when the head was tilted to the right side. The head position normalized when the right eye was patched but not when the left eye was occluded. The patient had a residual esotropia of 40 prism diopters at near and 25° at distance fixation. No nystagmus was present on casual observation. However, fundus examination with an ophthalmoscope with a built-in fixation target showed a jerk manifest nystagmus of high frequency with a temporal drift and a fast phase toward the nose. The frequency and amplitude increased with the head in a normal position and decreased when the head tilted to the right shoulder. Cycloplegia was absent on fundus examination and when tested with the Maddox double rod test. The parents requested treatment to correct the anomalous head posture. In view of finding that the patient would not hold fixation with the left eye, surgery was performed only on the right eye.

To rotate the right eye in the direction of the head tilt, that is to produce the right exotropia, we transposed the right superior rectus tendon nasally and the right inferior rectus tendon temporally. The day after the surgery the head was in a normal position and has remained so 12 months after surgery (Fig 5B). Visual acuity of the right eye was 20/20. Postoperative fundus photography showed exotroplia of the right eye (Fig 6). Subjectively, the patient was unaware of exocyclotropia after surgery and showed no cycloplegia on the Maddox double rod test.

Case 3. A 3½-year-old girl presented whose parents had noted nystagmus and a head tilt to the left shoulder. Her visual acuity tested binocularly was 20/20 with the head tilt and 20/40 with the head passively straightened. Her nystagmus was characterized as manifest, horizontal, jerky, and of large amplitude, increasing in right gaze and
decreasing on left gaze with the head tilted to the left shoulder. The head tilt was measured to be 25° (Fig 7A) with the torticollometer. Her refractive error was +1.25 sphere in each eye. Preoperative cover testing showed 12Δ exotropia at distance and near. Electro-oculography was performed while the patient fixated a visually detailed small toy at 1 meter fixation distance. The recordings showed a decrease of nystagmus when tilting the head to the left shoulder and an increase of the nystagmus when the head was passively straightened (Fig 8A).

At the age of 4 years, she underwent a temporal transposition of the right superior and nasal transposition of the right inferior rectus muscles, and a nasal transposition of the left superior and temporal transposition of the left inferior rectus muscles. When examined 6 months after surgery, a residual head tilt was present only when she was viewing extremely small targets at distance. It was not present under casual conditions (Fig 7B). An electro-oculogram obtained with the head in this improved position shows less nystagmus than had been present preoperatively when the head was passively straightened (Fig 8B). Her postoperative binocular visual acuity with the head in its normal position was 20/25.

Case 4. A 2-year-old girl presented with a history of esotropia with an onset shortly after birth and diagnosed by an ophthalmologist at 4 months of age. The onset of the strabismus at that time could be documented with photographs. A recession of both medial rectus muscles had been performed elsewhere. Except for an intermittent esotropia of 15° in downward gaze, the eyes were orthotropic. A cycloplegic refraction showed a refractive error of +3.50 D sphere in each eye. We observed latent nystagmus on the first visit but were unable to confirm this diagnosis during examinations. At age 2½ years, a head tilt to the left shoulder was noted. At age 3 years, the esotropia recurred and a resection of both lateral rectus muscles was performed. At age 4 years, a marked overaction of the left inferior oblique was noted when the patient fixated with the right eye. In addition, she had a dissociated vertical deviation in both eyes. Her refractive error had changed to +1.00 D sphere +2.25 cylinder axis 55 in the right and +1.00 D sphere +1.50 cylinder axis 120 in the left eye. With this correction and the head tilted to the left, visual acuity was 20/20 in the right eye and 20/30 in the left eye. With the head passively straightened, visual acuity was 20/20-3 in the right eye and 20/30 in the left eye. There was strong fixation preference for the right eye and
the left eye was suppressed. The head tilt disappeared upon
patching the right but persisted upon patching of the left
eye. The Maddox double rod test was negative for
cycloptropia. We performed a left inferior oblique myectomy
which eliminated the left hypertropia. However, the head
tilt to the left remained essentially unchanged, was
measured to be 20° (Fig 9A), and had become cosmetically
embarrassing. When the patient was 11 years old, we
transposed the right superior rectus muscle temporally and
the right inferior rectus muscle nasally. Because of the
strong fixation preference for the right eye, surgery was
limited to that eye. The head position immediately
normalized and remained normal when the patient was
reexamined 6 months after surgery (Fig 9B). Visual acuity

FIGURE 4: Case 1. Fundus photographs show (A) excycloduction of the right eye and (B) incycloduction of the left eye.

FIGURE 5: Case 2. (A) Preoperative head tilt and (B) postoperative normalization of head position.

FIGURE 6: Case 2. Fundus photograph shows postoperative excycloduction of the right eye.
in the right eye was 20/20 with the head in its normal position. A dissociated exodeviation of the left eye developed subsequently and responded well to a recession of the left lateral rectus muscle. Except for a latent nystagmus noted only during the first but not on subsequent examinations, this patient did not have nystagmus or cycloptopia, objectively or subjectively. The cause of the anomalous head posture could not be determined.

**Case 5.** This 7-year-old girl presented with a history of cranietomy performed in early childhood for cranioptasia. The patient had a developmental delay of about 2 years, had a short attention span, and was uncooperative during our examinations. She had an A-pattern exotropia of 40° in the primary position at distance, increasing to 70° in downward gaze. There was overaction of both superior oblique muscles. A head tilt to the right shoulder measured to be 20° improved upon patching the left eye. The head tilt to the right had been noted since age 1 year. We performed a 7-millimeter recession of both lateral rectus and a tenectomy of both superior oblique muscles. Postoperatively, the patient had a residual exotropia of 10° at near and distance and the A-pattern was no longer present. However, the anomalous head posture persisted. The patient preferred the left eye for fixation but could hold fixation with the right eye. Visual acuity with the right eye was 20/30 and 20/40 in the left eye with the head tilted. When the head was passively straightened, visual acuity in the left eye decreased slightly to 20/40-2. A manifest-latent nystagmus was noted and the head position improved upon patching either eye. Her refractive error was insignificant. On fundus examination, there was no torsion of either eye. We performed a nasal transposition of the right superior rectus, a temporal transposition of the right inferior rectus, a temporal transposition of the left superior rectus, and a nasal transposition of the left inferior rectus to rotate the eyes into the direction of the head tilt. Two months after surgery, an intermittent head tilt was still present. Visual acuity was 20/30 + 1 in the right eye and 20/20-2 in the left eye. The patient was lost to follow up.

**RESULTS**

Horizontal transposition of the vertical rectus muscles eliminated an anomalous head tilt in four of five patients. The fifth patient (case 5) was lost to follow up and it cannot be determined whether the head tilt disappeared with time.

Postoperative visual acuity, when tested with the head straight, improved slightly in all but one patient (case 2). This patient stated that she could see better with her head straight after surgery although the preoperative and postoperative visual acuity measurements in her right, preferred eye were unchanged (20/20). No complications occurred in terms of induced horizontal or vertical strabismus and none of the patients complained about postoperative diplopia, tilting of the visual environment, or other visual disturbances attributable to cycloptopia.

**COMMENTS**

This study shows that horizontal transposition of the vertical rectus muscles induced cycloduction of the eyes and may normalize ocular head tilt. These observations
confirm and further document the therapeutic approach of Conrad and de Decker, according to which in patients with head tilt, the eyes must be rotated around their sagittal axis in the direction of the anomalous head posture. Surgery was performed on both eyes when no fixation preference existed for either eye but was found to be equally effective when performed on the fixating eye in patients who had such a preference (cases 2 and 4).

The operation presumably works by introducing a tilt of the patient's subjective visual environment. For instance, in a patient with a head tilt to the right shoulder, excycloduction of the right eye and incycloduction of the left eye will cause a tilt of the patient's horizon downward to the left. To offset this tilt, the patient is forced to straighten the head. Interestingly, none of our patients when questioned 1 week after surgery was aware of a postoperative tilt of the visual horizon. We are planning to determine the subjective horizontal and vertical before and immediately after surgery in sufficiently cooperative subjects to study this adaptive phenomenon further.

Conrad and De Decker advocated advancement or recession of the anterior portions of the oblique muscle tendons, often combined with sagittalization of the insertions, to cycloduct the eyes. This technique has the advantage over the method described in this report, over vertical transposition of the horizontal rectus muscles and slanting of the insertions of all four rectus muscles, in that the blood supply to the anterior segment remains undisturbed. No comparative studies exist to evaluate the effectiveness and rate of complications of the different surgical methods currently in use. However, the operation on the insertions of the oblique muscles is technically demanding and, in our experience, caused a hypertropia in two patients who required additional surgery. It is for this reason that we searched for alternatives.

The usual precautions are in order when considering transposition of the rectus muscles in older patients who had previous muscle surgery. For instance, when previous surgery has been performed on the horizontal rectus muscle, it would be our choice to transpose the previously operated muscles vertically, as advocated by de Decker, in such patients rather than disturbing the insertions of the vertical rectus muscles. However, in children detachment of all rectus muscles is well tolerated, especially when there is a sufficient interval between operating on the horizontal and the vertical rectus muscles, as was present in cases 4 and 5 of this study.

The cause of an ocular head tilt in the absence of a cyclovertical muscle imbalance is not always clear. Obviously, the patient must derive some sensory advantage from assuming an anomalous and often uncomfortable head posture. In our patients, this advantage did not seem to exist in monocular vision since the head position normalized when either eye was patched. We believe that the head tilt in cases 1 to 3 was caused by a manifest congenital nystagmus since the nystagmus decreased on clinical observation when the head was tilted and we have documented this behavior in case 3. Apparently, the operation changes...
the innervational conditions that dampen the nystagmus when the head is tilted (neutral zone) so that this dampening prevails postoperatively without a head tilt.

The cause of the head tilt in cases 4 and 5 cannot be explained by a nystagmus or a cyclovertical muscle imbalance. Even though the measurable visual improvement in the abnormal head position was minimal, both patients mentioned that they could "see better" with the head tilted and complained about decreased vision when the head was passively straightened by the examiner. The etiology of the head tilt, which must be ocular in these cases since it was absent in monocular vision, remains unknown at this time. We have previously drawn attention to ocular torticollis without recognizable cause, and similar observations were reported by Conrad and de Decker. It is possible that the head tilt in case 4 was related to the dissociated vertical deviation as part of the essential esotropia syndrome. Longer follow-up periods are required to determine whether a head tilt will recur after surgery. We have not observed such recurrences in our patients but recognize the possibility that the horizontal rectus and oblique muscles which remain attached to the globe in conjunction with mechanical forces from the peribulbar tissues may eventually counteract the effect of surgery. One must also consider the possibility that with the passage of time, the patient may become sensorially adapted or otherwise learn to compensate for the induced tilt of the visual environment, in which case the stimulus to straighten the head may no longer exist.

FIGURE 9: Case 4. (A) Preoperative head tilt and (B) postoperative normalization of head posture.

REFERENCES