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CASE REPORT

Comprehensive Surgical Approaches for Paralytic Esotropia

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Abstract

Introduction: Paralytic esotropia occurs due to paralysis of the lateral rectus muscle due to sixth nerve paralysis. One of the etiologies of sixth nerve palsy is trauma. Examination and holistic management should be done in patients with sixth nerve palsy, as this condition will have a psychosocial impact on the patient. In this case series, the authors will report on the different approaches to comprehensive management in paralytic esotropia cases. **Case Presentation:** The first patient had 30Δ paralytic esotropia in the right eye for ten months after an accident, experiencing diplopia in the primary gaze worsening in the left gaze, with abduction limitation. He underwent a 7 mm medial rectus recession as the first step, followed by vertical rectus transposition with Foster modification after three months. This treatment successfully restored orthophoria with no diplopia in the primary gaze. The second patient developed paralytic esotropia (10) after a traffic accident one year prior, with minimal motility limitation. He underwent a 4 mm medial rectus recession, restoring binocular vision and allowing him to return to work. **Conclusion:** Sixth cranial nerve paralysis is the most common cause of eye-related nerve paralysis, leading to loss of lateral rectus muscle function, diplopia, and significant psychosocial impacts. Surgical treatment for chronic paralytic esotropia depends on the severity of muscle weakness, with different procedures recommended based on the ability of the lateral rectus to contract. Case studies showed that appropriate surgical interventions, such as medial rectus recession and vertical rectus transposition, effectively managed the condition and improved patient outcomes.

Keywords: paralytic esotropia; Foster modification suture; full tendon vertical rectus transposition

Introduction

Paralytic esotropia occurs due to paralysis of the lateral rectus muscle due to sixth nerve paralysis. One of the etiologies of sixth nerve palsy is trauma.[1] The patient will complain of diplopia and squinted eyes. Paralysis of the sixth cranial nerve, also known as the abducens nerve, will cause incomitant esotropia.[2]

Examination and holistic management should be done in patients with sixth nerve palsy, as this condition will have a psychosocial impact on the patient. The choice of the surgical technique will depend on the muscle action of the lateral rectus and the degree of the ocular motility limitation. Paralytic esotropia management aims to improve the alignment of the eye and diminished diplopia that will affect the patient's job performance of the patient.[2] In this case series, the authors will report on the different approaches to comprehensive management in paralytic esotropia cases.

Case presentation

Case 1

A 39-year-old man came to our clinic complaining of a squint in his right eye ten months ago (Figure 1). The complaint arose after the patient had a traffic accident. The sight of both eyes is blurred after an accident accompanied by double vision in the primary gaze, which worsened in the right gaze. There was also lagophthalmos. There was a history of surgery in the patient's medial rectus

Figure 1. Hirschberg test 30.

Figure 2. The right eye lagopthalmus 5 mm and left lagopthalmus 2 mm.

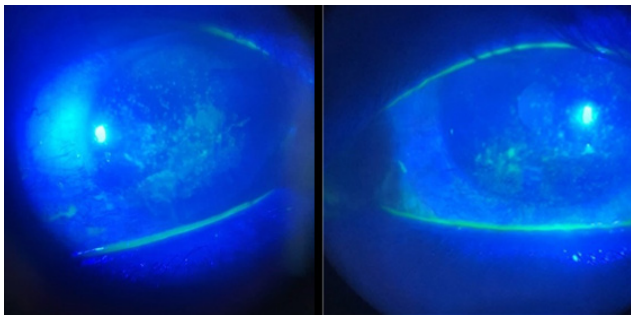


Figure 3. The fluorescein test on both eyes is positive; (A) The right eye; and (B) The left eye.

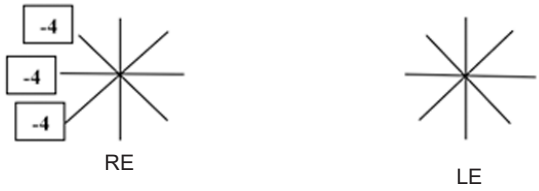


Figure 4. Ocular motility case one, we found -4 limitation in the temporal, superotemporal, and inferotemporal gaze.

recess 7 mm on his right eye three months ago at Dr. Soetomo General Hospital, Surabaya, East Java, Indonesia.

Physical examination revealed visual acuity in the right eye, with a 5/40 pinhole, which was not improved, and in the left eye, with a 5/40 pinhole, 5/20. Examination of the anterior segment of the eyeball revealed Bell's Phenomenon in both eyes. On the lid of the right eye is a 5 mm lagophthalmos, and on the left eye is a 2 mm lagophthalmos (Figure 2). There was punctate keratopathy due to the lagopthalmus on both eyes (Figure 3).

Ocular motility in the right eye was limited to -4 in temporal, superotemporal, and inferotemporal gazes (Figure 4). We found incomitant esotropia of the right eye. 30Δ is in the primary position (far and near), and there is also upgaze and down gaze (Figure 5-6). Worth four dot test (WFDT) found suppression in the far and near right eye. The force generation test showed negative results, and the force deduction test showed no resistance. A brain magnetic resonance imaging (MRI) examination revealed esotropia on the right eye, atrophy of the right lateral rectus, and left mastoiditis (Figure 7).

The diagnosis is based on the patient's information, etiology, and clinical condition. The patient was diagnosed with right eye paralytic esotropia caused by paralytic sixth nerve, right and left eye lagopthalmus, and right and left eye exposure keratitis. The patient underwent right eye all vertical rectus transposition surgery with Foster modification suture. The choice of action is based on the patient's complaints, limited eye movement, MRI results, and the inability to constrict the lateral rectus muscle. Orthophoria results were obtained in the primary gaze so that the patient's complaint of diplopia was resolved.

Case 2

A man, 30-year-old came with complaints of diplopia and crossed eyes since he had a traffic accident one year ago, which caused him to suffer from a carotid-cavernous fistula. Embolization was performed immediately and successfully, but diplopia and esotropia remained after embolization (Figure 8).

On eye examination, the visual acuity of both eyes was 6/6. Hirscbergh examination obtained <15 degrees of esotropia, prism cover test obtained 10Δ incomitant esotropia, and examination of the eyeball found that there was minimal ocular motility in the right eye -1 in the temporal gaze (Figure 9).

The WFDT examination showed diplopia in the near and far gaze. Stereoacuity test using the randot test results are 140 arc second. The saccadic movement has minimal floating, and force generation has positive results. There still was lateral rectus muscle action.

Figure 5. In the nine gaze positions, we found limitations -4, such as temporal, superotemporal, and inferotemporal gaze in the right eye.

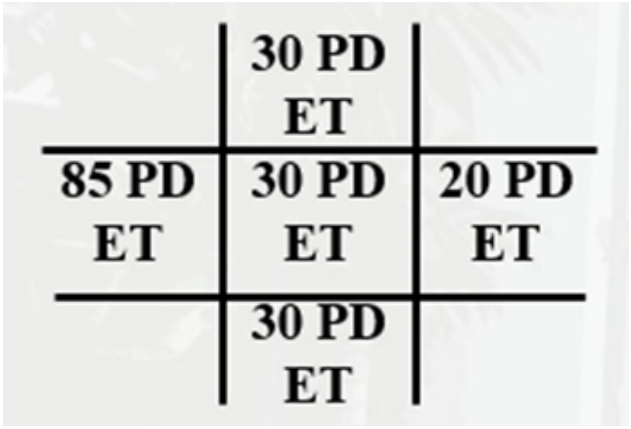


Figure 6. The Krimsky case one; 85Δ temporal gaze in the right eye.

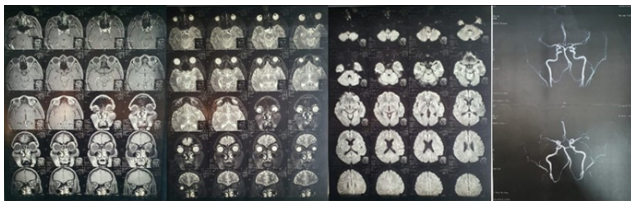


Figure 7. A brain MRI examination revealed esotropia on the right eye, atrophy of the right lateral rectus, and left mastoiditis.

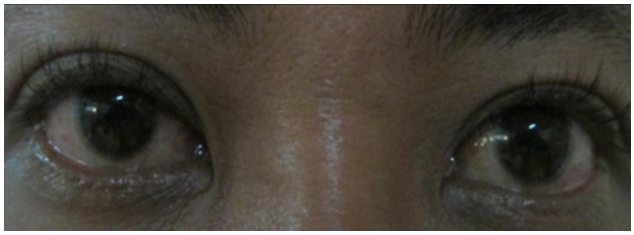


Figure 8. Hirscbergh examination obtained < 15 degrees of esotropia.

Figure 9. Ocular motility case two, we found a -1 limitation in the temporal gaze in the right eye.

The patient was diagnosed with acquired paretic esotropia. The initial management used glasses with 5Δ, with base-out lenses in the right and left eyes, however, he complained that diplopia persisted. Because this condition interfered with the patient's ability to work, we performed monocular surgery based on residual lateral rectus muscle action with medial rectus muscle recession in the right eye of 4 mm. Orthoporia results were obtained, there was no diplopia and improved binocular vision, thereby increasing patient productivity at work.

Discussion and conclusions

Ocular motor cranial nerve palsies (OMCNP) is an abnormality that causes impediments in eyeball movement. The third, fourth, and sixth nerves innervate the eyeballs. In research performed within the ophthalomology department of Dr. Soetomo General Hospital, Surabaya, East Java, Indonesia, 86 patients were diagnosed with esotropia paralytic, caused by the paralysis of the sixth cranial nerve with the cause of neoplasm (24.9%), trauma (33.7%), intra-cranial processes (22.1%), idiopathic (3.5%), other causes (3.5%), and congenital (2.3%). In this serial case, both patients had paralysis of the sixth cranial nerve caused by the trauma factor.

The paralysis of the sixth cranial muscle will also result in horizontal diplopia, worsening the ipsilateral view, in correlation with the abduction deficit and rising esodeviation on the affected side (Figure 11).[3]

The sixth cranial nerve (abducens nerve) is highly susceptible to head trauma or increased intracranial pressure, particularly when entering the cavernous sinus through Dorello's canal.[3] In both patients, paralytic esotropia resulted from post-traumatic injury. The first patient experienced complete abducens nerve paralysis, leading to an inability to abduct the right eye, with medial deviation (esotropia) and diplopia in all gaze positions (Figure 11).[2] The second patient had partial abducens nerve paresis, resulting in limited abduction, diplopia, and strain during lateral gaze.

There are two categories of mechanisms concerning trauma-induced abducens nerve paralysis, namely direct and indirect injuries. Generally, head injuries are caused by two fundamental mechanisms, namely contact and acceleration. Both of these mechanisms could result in the avulsion of the petrous bone from the foramen lacerum to the outer side of the bone. It could directly injure the nervous abducens.[4]

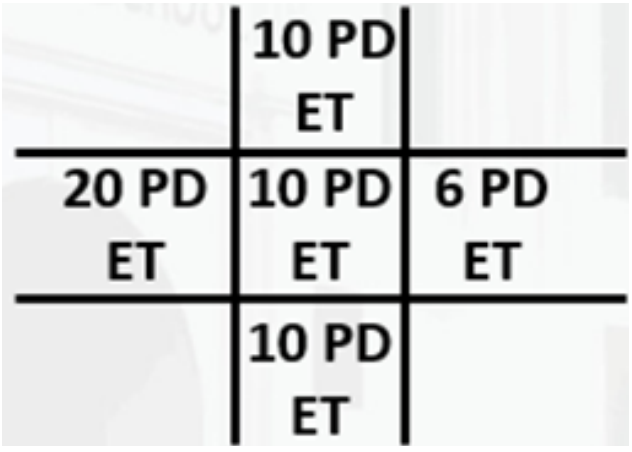


Figure 10. Krimsky case two; 20Δ temporal gaze in the right eye.

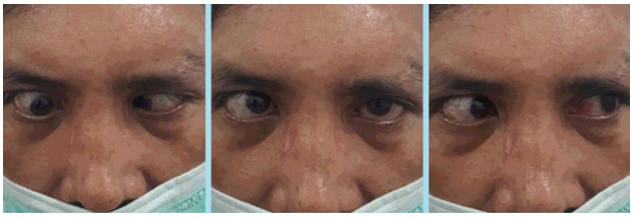


Figure 11. Right cranial nerve VI palsy; (A) Right gaze; (B) Primary gaze; (C) Left gaze.

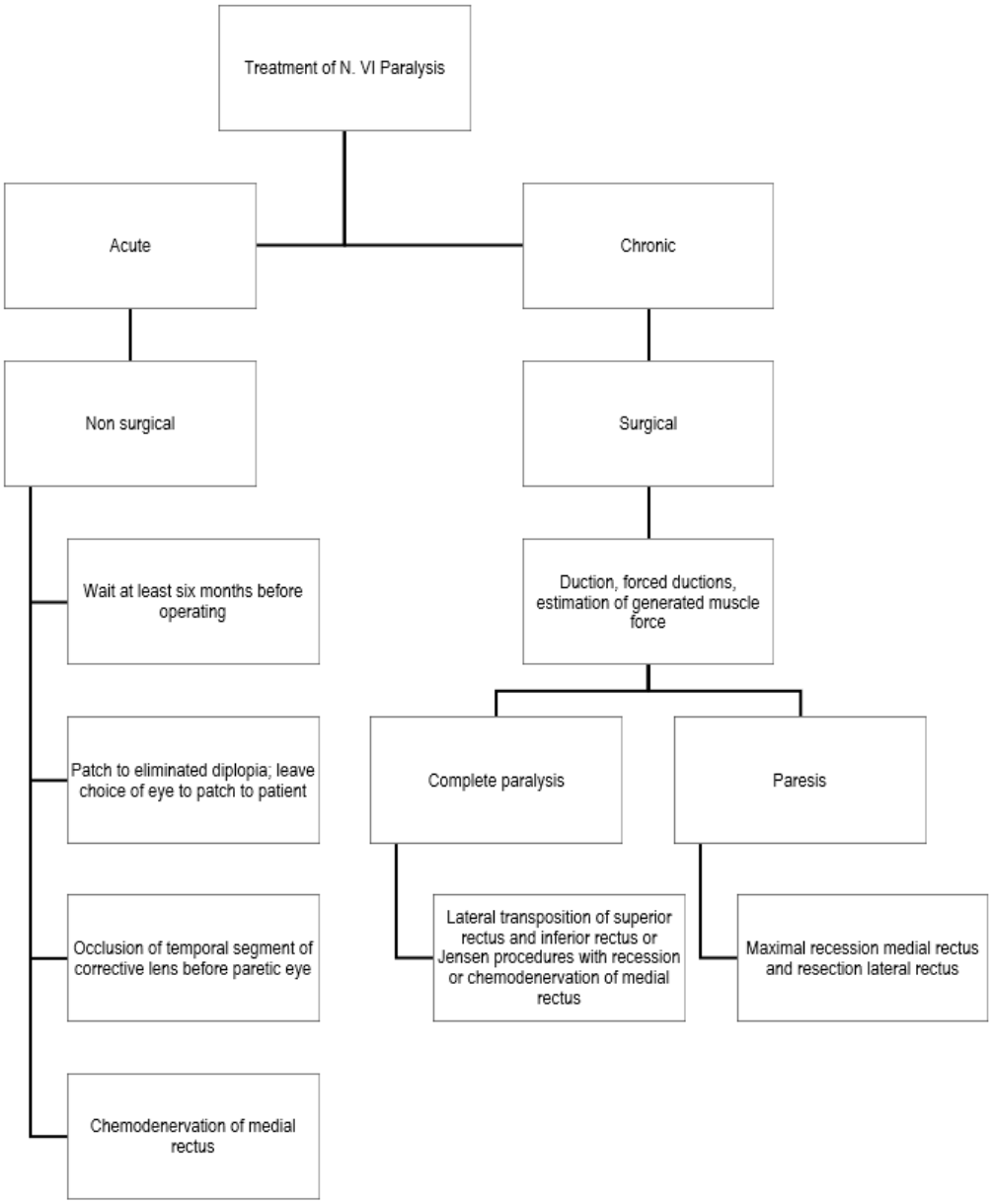


Figure 12. Sixth nerve paralysis-treatment.

Azarmina & Azarmina[5], identified six syndromes associated with abducens nerve abnormalities, namely brainstem syndrome, elevated intracranial pressure syndrome, petrous apex syndrome, cavernous sinus syndrome (CSS), orbital syndrome of the sixth nerve, and isolated sixth nerve palsy Syndrome.

The first patient exhibited symptoms consistent with isolated sixth nerve palsy, characterized by lateral rectus muscle weakness, which may result from central or peripheral abducens nerve palsy. Meanwhile, the second patient presented with clinical features suggestive of CSS, considering that the abducens nerve within the cavernous sinus is closely related to the third, fourth, and fifth cranial nerves, the internal carotid artery, and the carotid sympathetic plexus.

A comprehensive history-taking plays a crucial role in establishing the diagnosis. In the first patient, the chief complaint was the medial deviation of the left eye since a traffic accident one year prior, accompanied by diplopia and strabismus, leading to the inability to work. Ocular motility examination revealed a -4 restriction in abduction, superolateral, and inferolateral movements without pain in the right eye, while the left eye showed no abnormalities (Figure 4). The cover test indicated esotropia in the right eye, whereas the alternate cover test was negative. Hirschberg test showed 15-degree esotropia in the right gaze. Krimsky test demonstrated 30Δ esotropia in near-far and upgaze-downgaze, 20Δ in left gaze, and 85Δ in right gaze (Figure 5). In the second patient, there was a -1 restriction in abduction without pain in the right eye (Figure 9). Hirschberg test showed <15-degree esotropia, while the prism cover test revealed 10Δ esotropia.

Other than anamneses and eye clinical examinations, supporting tests may also have significant roles, such as computed tomography (CT), which uses X-rays to obtain the value of tissue density generated by computers. CT-scan is performed to evaluate structural injuries in the

Table 1. Based on surgical options.

	Case 1	Case 2
Saccadic Movement	Floating	Minimal Floating
Force Generation Test	Negative	Positive
Forced Duction Test	Full (No restrictive)	Full (No restrictive)
Surgical Choice	Transposition	Recess

Table 2. Surgical dose by Hesgaard and Wright[7]

Binocular surgery		
Esotropia		
	MR OU recession (mm)	**LR OU resection (mm)**
15Δ	3.0	3.5
20Δ	3.5	4.5
25Δ	4.0	4.0
30Δ	4.5	6.0
35Δ	5.0	6.5
40Δ	5.5	7.0
50Δ	6.0	8.0
Exotropia		
	LR OU recession (mm)	**MR OU resection (mm)**
15Δ	4.0	3.0
20Δ	5.0	4.0
25Δ	6.0	5.0
30Δ	7.0	5.5
35Δ	7.5	6.0
40Δ	8.0	6.5
50Δ	9.0	7.0
Monocular surgery		
Esotropia		
	MR recession (mm)	**LR resection (mm)**
15Δ	3.0	3.5
20Δ	3.5	4.0
25Δ	4.0	5.0
30Δ	4.5	5.5
35Δ	5.0	6.0
40Δ	5.5	6.5
50Δ	6.0	7.0
Exotropia		
	LR recession (mm)	**MR resection (mm)**
15Δ	4.0	3.0
20Δ	5.0	4.0
25Δ	6.0	4.5
30Δ	6.5	5.0
35Δ	7.0	5.5
40Δ	7.5	6.0
50Δ	8.5	6.5

skull base, clival fractures, intracranial hemorrhage, or lesions causing compression of the abducens nerve. This examination helps differentiate abducens nerve palsy due to direct trauma from secondary causes such as stroke, tumors, or increased intracranial pressure.[6] The CT-scan results on the first patient stated that there was atrophy of the right lateral rectus, which indicated that all vertical rectus transposition with Foster modification sutures had been performed.

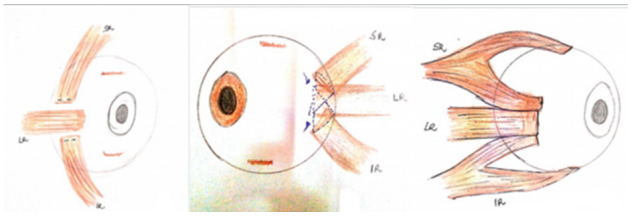
The indication of strabismus operation was divided into two categories: the binocular function and the appearance of cosmetics with psychosocial impacts. The resect recess operation resulted in the presence of incomitant. Incomitant is capable of causing diplopia. Monocular surgery is the preferred procedure to safeguard the remaining healthy eye.[7]

In the first case, the patient obtained two operation steps due to paralysis of the sixth cranial nerve, resulting in the lateral rectus muscle being incapable of contraction. The patient obtained right eye recess rectus medial 7 mm in the first operation. Then, three months following the first operation, all vertical rectus transposition treatments with Foster modification suture were performed. Such treatments provided additional actions capable of compensating the eyeball position to become orthophoria with no diplopia at the primary gaze position (Table 1).

In the second case, the patient complained of diplopia gaze. Results of ten dioptric prisms were obtained during the examination utilizing the prism. The lateral rectus muscle could contract, but there were some signs of weakness. The patient was, therefore, diagnosed with acquired paretic esotropia. As such, right eye recess rectus medial 4 mm was treated (Table 1).

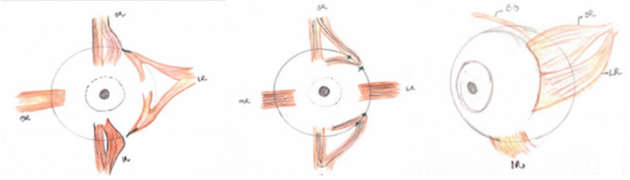
The management of sixth cranial nerve paralysis is classified into acute and chronic onset.[8] Both patients had a chronic onset as their symptoms persisted for over six months. Prism glasses were ineffective for the second patient, who continued to experience diplopia. Surgical selection depends on muscle function, assessed by the force generation test. Maximal medial rectus recession and lateral rectus resection are options if contraction is present. If the test is negative, vertical rectus transposition is the preferred approach (Figure 12).

Different types of horizontal concomitant strabismus require specific considerations.[9] Table 2 provides surgical planning guidelines, adapted from Parks' method with modifications by Hesgaard & Wright[7] based on his surgical experience. For deviations > 50Δ, surgery involving up to three muscles is recommended. The choice of procedure depends on age, fusion potential, and visual acuity.[10] The goal is to realign the eyes to 8-10Δ to promote binocular vision, as excessive esotropia prevents proper fusion. If ≥ 10Δ residual esotropia persists, additional treatment should be considered.[7]



A B C

Figure 13. (A) Complete tendon transposition; (B) Crossed-adjustable technique; (C) Hummelsheim procedure[11].



A B C

Figure 14. (A) Jensen's procedure; (B) Nishida's Procedure; (C) Superior Rectus transposition (SRT)[11].

Figure 15. Case 1: The right eye post op full tendon vertical rectus transposition and foster suture second day's.

Vertical rectus transposition (VRT) is performed in complex cases to enhance lateral rectus contraction, restoring orthophoria in primary gaze.[1] It can be combined with posterior augmentation (Foster suture), which improves abduction while minimizing adduction limitations and reducing the risk of anterior segment ischemia. Complete tendon transposition using the superior, inferior, or vertical rectus muscles is recommended for sixth nerve paralysis. Potential complications include horizontal and vertical residual deviations, ocular torsion, and anterior segment ischemia.[1]

There are several techniques of transposition procedures for sixth nerve palsy, including complete tendon transposition, crossed-adjustable technique, Hummelsheim procedure (Figure 13), Jensen's procedure[11], Nishida's procedure, superior rectus transposition (SRT) (Figure 14) and inferior rectus transposition (IRT).

Complete tendon transposition involves the full-width tendon dis-insertion of the vertical rectus muscles. The disinserted vertical muscle is then moved near the lateral rectus. In order to prevent risks of ischemia toward the anterior segments, the vertical rectus must be carefully dissected to maintain the ciliary anterior artery branch; this technique was applied in our first case and brought decent results (Figure 15).

Most strabismus patients also experience diplopia, which negatively affects their quality of life. For example, in the second case, the patient suffering from diplopia lost their job as a building surveyor. Hatt et al.[12], stated that quantitatively measurable diplopia is directly related to the deterioration of psychosocial aspects and peripheral vision perception. Strabismus treatment can positively impact an individual's ability to interact and regain their previous job socially[12] Therefore, strabismus treatment should not be considered purely cosmetic, even though there is believed to be no hope of restoring binocular vision.[13]In the first patient, complaints of diplopia had been resolved, and the eye position was orthophoria during primary gaze, although complaints of double vision were still felt when glancing. As the head of the family, the patient hopes to be able to work again. With current conditions, the patient is optimistic that he will get a job. The same thing happened to the second patient; as a building surveyor, binocular vision is required, and this cannot be achieved just by using prism glasses; after the lateral rectus recess procedure was carried out, the patient regained his binocularity.

The paralysis of the sixth cranial nerve is the most common cause of eye-related nerve paralysis, leading to the loss of the lateral rectus muscle's ability to contract. Patients often experience diplopia and inward rolling of the affected eyeball, which can also cause severe psychosocial effects, such as job loss.

Surgical options for chronic paralytic esotropia depend on the lateral rectus muscle's weakness, as measured by force generation tests.[14] Maximal medial rectus recession and lateral rectus resection may be preferred if contraction is still possible. If not, all vertical rectus transposition is recommended.[15]

In our first patient, two surgeries were performed: a 7 mm medial rectus recession followed by all vertical rectus transposition with Foster modification. For the second patient, prism-lens glasses were ineffective, so a 4 mm medial rectus recession was done. The choice of surgery was crucial for the successful management of paralytic esotropia, yielding satisfactory results for both patients.

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