NEURO-OPTOMETRIC VISION REHABILITATION AFTER PONTINE CAVERNOMA: A CASE REPORT

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Abstract

It is common to have vision problems after neurological insults such as traumatic brain injury, stroke or brain tumours. While these neurological insults can affect patients' daily functioning to different extents, vision problems can be the main obstacle to the dysfunction. A 19-year-old boy with pontine cavernoma presented to the clinic with multiple visual problems at ten months after surgical removal of the tumour. He has left 6th cranial nerve palsy with persistent diplopia and nystagmus. These were associated with giddiness, imbalance, cerebellar impairments, right hemiparesis and hemisensory loss. This case illustrates the importance of adding the neuro-optometric vision rehabilitation, which include visual information processing therapy and other substitutive interventions, into the existing multidisciplinary rehabilitation program to achieve the greatest functional benefit.

Keywords**:** Brain Injury, Neuro Optometric Vision Rehabilitation, Vision Problem, Vision processing

Introduction

Eight to thirty-five percent of intracranial cavernoma cases occur at the brainstem, with a predilection for the pons (1). Common clinical manifestations include impaired ocular motility and facial lesions. A person may have inconsistent pursuit and saccade movements, diplopia, and strabismus disorders. These visual disorders may affect the overall progress achieved from neurorehabilitation if they are not addressed specifically. We describe a young patient presented to us with multiple visual problems at ten months after surgical removal of a pontine cavernoma, and how we employed neuro-optometric vision rehabilitation as part of the holistic management regimen.

Case presentation

A 19-year-old boy presented at the surgical clinic with left eye convergent strabismus for six months, associated with giddiness and imbalance. He also developed left facial drooping and left-sided body numbness at around the same time. An initial magnetic resonance imaging (MRI) of the brain showed a well lobulated lesion measuring 1.7 x 2.4 x 2.0 cm at the level of mid-pons extending superiorly to the left superior cerebellar peduncle and cerebral aqueduct and inferiorly to the left side of 4th ventricle. The lesion demonstrated mixed signal with low signal hemosiderin rim on T2 image, and several areas of high signal intensity on the T1 image with blooming artefact on gradient echo image. Those features are suggestive of a pontine cavernoma. He underwent craniotomy and excision of the tumour. Histopathological examination results were consistent with brainstem cavernoma. Post-surgery, he received a short period of outpatient physiotherapy program.

He was referred to the medical rehabilitation clinic at ten months after surgery for a comprehensive rehabilitation program. On assessment, he had multiple impairments which included dysarthria, bilateral intentional tremor, dysmetria and dysdiadochokinesia; right hemiparesis and hemisensory loss with loss of proprioception, ataxia and left 6th cranial nerve palsy. He was enrolled into the inpatient neurorehabilitation program. The rehabilitation planning for this patient was based on the WHO-International Classification Functioning (WHO-ICF) health model (Figure 1).

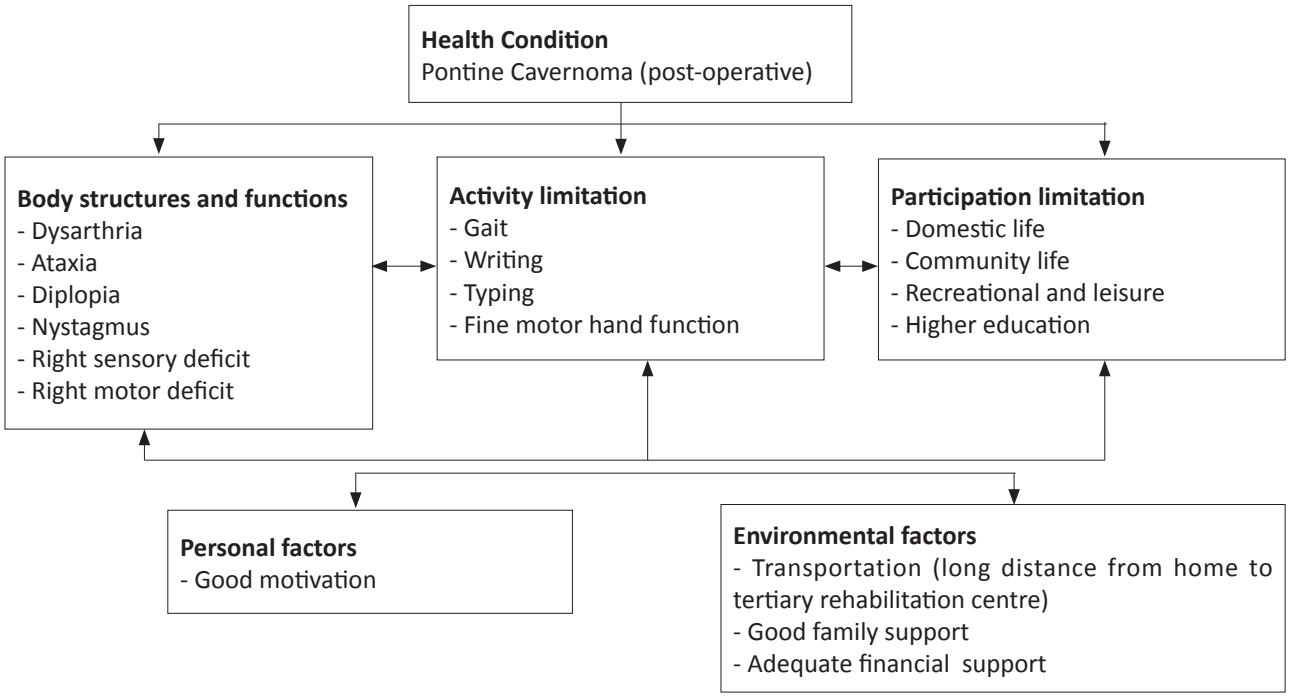


Figure 1: The illustration of WHO-ICF framework for this patient

The neurorehabilitation program incorporates various rehabilitation team members, namely the doctors, physiotherapists, occupational therapists, speech therapists and rehab nurses. WHO-ICF allows the rehabilitation team members to look beyond their own areas of practice and communicate across disciplines. During the inpatient stay, he was prescribed with strengthening exercises, endurance training, balance and gait training using a robotic end effector machine and ground walking with compressive garments and weighted sandbag; sensory re-education training, oromotor exercises and speech therapy. He was also given aids and adaptation such as weighted cuff, adapted pen holder, adaptive nail cutter to improve his level of self-care and functional independence. Functional task trainings such as writing, typing and computer handling were provided as well.

His functional progress was minimal; mainly due to the vision problems. Three months later, we referred him to a neuro-developmental optometrist in a private vision therapy centre for neuro-optometric vision rehabilitation. From the optometric vision assessment, he showed a 52 prism diopter deviation at 6 meters, estimated with the fresnel prism; but persistent diplopia at difference distances (6 meters, 3 meters, 1 meter and 50 cm). No vertical deviation was noted. He reported about 10 degrees diplopia with the right side gaze. He also showed nystagmus which was more pronounced on his left horizontal gaze.

The frequency of the visual rehabilitation program was once in a fortnight, for 45 minutes per session. The patient underwent 24 sessions which included interventions such as basic visual motor skills, eyes stretch and range of movement, laterality training, central-peripheral awareness, stimulation of the lateral rectus of left eye with post-vestibular ocular reflex, selective occlusion, yoked prism and relieve prism. The patient was also prescribed with home visual rehabilitation therapy activities for 15 to 20 minutes daily. Other trainings also involved visual information processing therapy, e.g. visual searching, figure ground, visual closure and visualization skills. The related optometric findings before and three months after the start of the neuro-optometric vision rehabilitation are listed in Table 1, whereas the pursuit and saccade test findings are listed in Table 2. Figure 2 illustrates the 9 gaze test findings.

He also continued with the outpatient neurorehabilitation program at twice a week. His overall functional outcome improved after the neuro-optometric vision rehabilitation was incorporated in the neurorehabilitation program (Table 3).

Discussion

Vision is a primary sensory modality which involves in up to 80 % of our perception, learning, cognition and activities (3). Eye movement disorders lead to potential adverse effects on basic eye tracking, reading, visual scanning, and higher-order visual information processing along with other visual tasks. In patients with brainstem cavernoma, about 49 % of them experience oculomotor disturbances (4). Patients usually manifest with symptoms of blurred vision, double vision, impaired depth perception, convergence insufficiency, exophoria, wobbling and jumbling of images, and reading difficulty.

Oculomotor dysfunction may adversely affect the progress of neurorehabilitation. This is because most of the rehabilitation interventions involve the visual system; for

Table 1: Optometric findings before (baseline) and 3 months after the start of the neuro-optometric vision rehabilitation (VR)

Test	Baseline	After VR
Diagnosis and Result	Oculus sinister incomplete closure and 6th nerve paresis	Oculus sinister incomplete closure and 6th nerve paresis
Non-diplopia Range (the only point that does not have diplopia)	1 cm from nose	4 cm from nose
9 Gaze Test	refer to Figure 2a 6th nerve paresis at left eye caused severe diplopia of variable magnitude (incomitant) Left eye unable to move to his left gaze, which is 0 scale. nystagmus appeared on horizontal gaze. The right eye was worse than left eye	refer to Figure 2b Primary gaze showed Left esotropia, but Patient is able to move his eyes to his left temporal side, would estimate 4 scale, as maximum is 6 scale.
Pursuit and Saccade Test	Refer to Table 2 for the results	
Distance Subject Refraction	moderate myopia and astigmatism - right eye: -6.50 -1.00 x 180 20/25. left eye: -6.00 -1.00x180 20/25	Same as baseline
Colour vision with Ishihara Test	Passed 17/17	Same as baseline
Relieve prism (Fresnel) for neutralizing double vision	right eye 12 base out left eye 40 base out however, due to the incomitant, there was persistent diplopia at different distances. The Fresnel prism was not prescribed.	right eye 10 base out left eye 35 base out however, due to the incomitant, there was persistent diplopia at different distances. The Fresnel prism was not prescribed.
Post Nystagmus Rotary Test	performed stimulate left eye lateral rectus in the action of abduction, left eye was able to move to mid centre temporal position	Same as baseline
Management	prescription of nasal occlusion 24 mm on the left eye to eliminate the diplopia starts the neuro-optometric VR office sessions	prescription of nasal occlusion 18 mm on left eye to eliminate the diplopia to continue the neuro-optometric VR office sessions

Table 2: Pursuit and saccade test findings before and 3 months after the start of the neuro-optometric vision rehabilitation (VR) using the Northeastern State University College of Optometry (NSUCO) Oculomotor test (2).

	NSUCO scores at baseline		NSUCO scores after VR	
	Pursuits	**Saccade (Horizontal & Vertical)**	**Pursuits**	**Saccade (Horizontal & Vertical)**
Ability	2	2	3	3
Accuracy	2	3	3	3
Head movement	1	1	3	3
Body movement	1	1	3	3

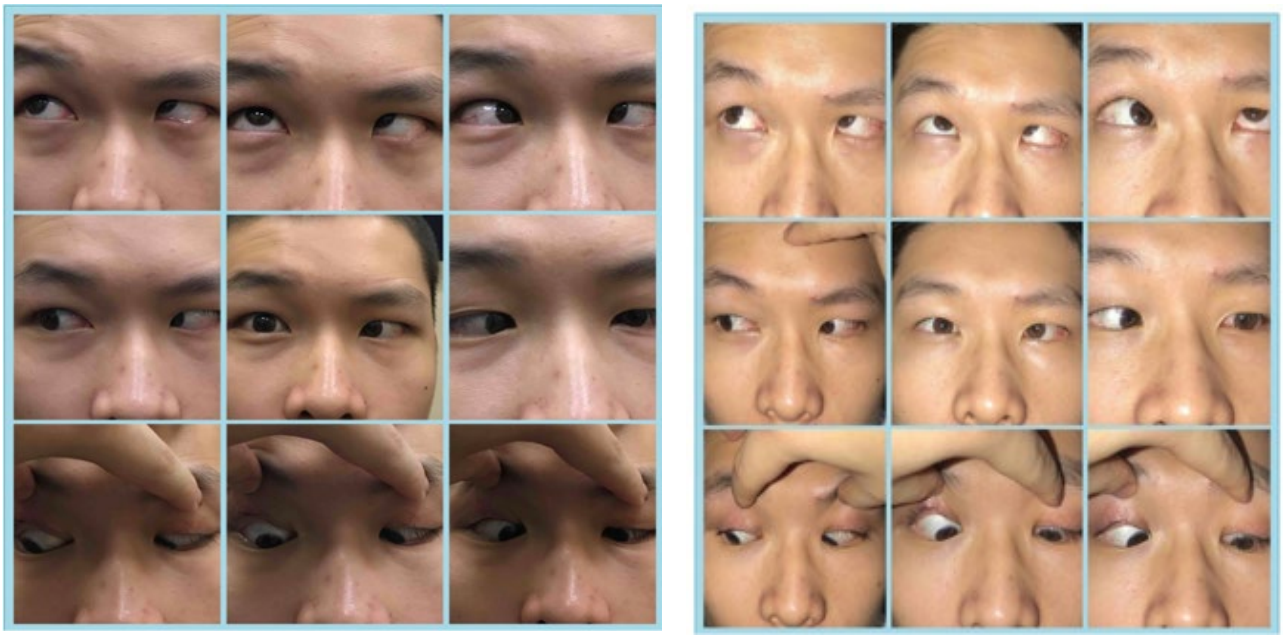
Scoring:
PURSUIT ABILITY
1. Cannot complete 1/2 rotation in either the clockwise or counter-clockwise direction
2. Completes 1/2 rotation in either direction
3. Completes one rotation in either direction but not two rotations
4. Completes two rotations in one direction but less than two rotations in the other direction
5. Completes two rotations in each direction

PURSUIT ACCURACY
1. Refixations more than 10 times
2. Refixations five to 10 times
3. Refixations three or four times
4. Refixations two times or less
5. No refixations

SACCADE ABILITY
1. Completes less than two round trips
2. Completes two round trips
3. Completes three round trips
4. Completes four round trips
5. Completes five round trips

SACCADE ACCURACY
1. Large over- or undershooting is noted one or more times
2. Moderate over- or undershooting noted one or more times
3. Constant slight over- or undershooting noted (greater than 50 % of the time)
4. Intermittent slight over- or undershooting noted (less than 50 % of the time)
5. No over- or undershooting noted

HEAD AND BODY MOVEMENTS
1. Large movement of the head (body) at any time
2. Moderate movement of the head (body) at any time
3. Consistent slight movement of the head (body) (greater than 50 % of the time)
4. Intermittent slight movement of the head (body) (less than 50 % of the time)
5. No movement of the head (body)



2a 2b

Figure 2: 9 Gaze Test findings before and after neuro-optometric vision rehabilitation. 2a: Before the Neuro-optometric Vision Rehabilitation. 2b: After 3 months of Neuro-optometric Vision Rehabilitation.

Table 3: The functional outcome measures at baseline (before neurorehabilitation), at 3 months after neurorehabilitation and at 1 year, after neuro-optometric vision rehabilitation (VR) and neurorehabilitation

Outcome measures	Baseline	At 3 months after neurorehabilitation	At 1 year, after VR + neurorehabilitation
BBS	10/56	16/56	17/56
TUG	3min, 51sec. with walking frame	2min, 2 sec. with walking frame	1min, 50sec. with walking frame
6MWT	-	12 metres with walking frame	29 metres with walking frame
MBI	59/100	81/100	86/100
BBT	Right: 11 blocks Left: 33 blocks	Right: 17 blocks Left: 35 blocks	Right: 17 blocks Left: 47 blocks
SARA	17/40	-	14.5/40
Writing speed	-	left hand: 2 words per min.	left hand: 7 words per min.
Typing speed	-	5 words per min	8 words per min

BBS= Berg's Balance Scale, TUG= Time Up & Go, 6MWT= 6 minutes' Walk Test, MBI= Modified Barthel Index, BBT= Box and Block Test, SARA= Scale of Assessment and Rating of Ataxia

example, eye hand coordination and visual-led motor/hand on localizing an object. In this patient's context, the goals of neurorehabilitation interventions such as to improve ataxia, balance, gait, and hand function, would be limited if the abnormal vision condition was not diagnosed or treated appropriately.

Ciuffreda (5) defined neuro-optometric vision rehabilitation as "an intervention that involves oculomotor integration with the head, neck, limbs, and overall body with information from the other sensory modalities, producing temporally efficient, coordinated behaviour within a context of harmonious spatial sense under a variety of external and internal conditions and states". It is guided by evidence-based practice and principles related to neuro-developmental and rehabilitative optometric perspective. Neuro-optometric vision rehabilitation is also based on neuroplasticity whereby experience-dependent processes helps to facilitate formation of functional neural networks. Maladaptation can happen due to inappropriate experience, toxic stress, and poor social support, whereas beneficial adaptations can result from appropriate, timely experiences, and proper support. Repetition is needed

to maintain, strengthen, refine, and elaborate the target neural circuitry (6).

Interventions for eye movement disorders are diverse and they can be categorized into restitution, compensation and substitution (7). This patient was treated with a combination of strategies. The restitutive interventions were visual motor skill, eye stretch, laterality training, central-peripheral awareness and stimulation of the lateral rectus of left eye with post-vestibular ocular reflex. Visual information processing therapy was considered as a compensatory intervention. This patient was prescribed with selective occlusion, yoke and relieve prism as substitutive interventions.

In most patients with diplopia, monocular occlusion or patching is prescribed, as it is a common, quick and cost-effective method to relieve symptoms. However, monocular vision causes the loss of stereopsis, reduction of peripheral visual field and worsens spatial bias (8). Selective occlusion is a preferable method as it reduces diplopia and allows improved balance, mobility, field of vision, and cosmesis as compared to full patching (9). As part of his neuro-optometric vision rehabilitation, this patient was prescribed with selective left nasal occlusion (Figure 3), using a small patch blurring film placed on the inside of the lens of his glasses and directly in the line of sight contributing to the diplopia on the left nasal part. Its size and placement are finalized by evaluating different sizes and shapes which effectively eliminates the diplopia.

This patient showed steady improvement in his functions, especially hand's dexterity, visual motor localization, and mobility. These improvements were likely associated

Figure 3: Selective left nasal occlusion (using a small patch blurring film which was placed on the inner part of the lens, and directly in the line of sight contributing to the diplopia on the left nasal part). This photo is taken at the baseline before rehabilitation.

with the improvement in binocular vision with use of selective occlusion (10). His nystagmus was reduced as well. However, he did not show much improvement in higher balance which could be affected by other factors, including somatosensory and proprioception impairment, low physical endurance and cerebellar ataxia.

Conclusion

Rehabilitation after pontine cavernoma surgery is challenging due to its multiple impairments and complications. A multidisciplinary neurorehabilitation approach is important to produce a positive outcome. We want to highlight the importance of neuro-optometric vision rehabilitation for patients manifesting visual impairments, especially in acquired brain injury cases such as brain tumours. This case has shown that neuro-optometric vision rehabilitation improves the overall functions when paired together with a comprehensive neurorehabilitation intervention. Since neuro-optometric vision rehabilitation is not readily available in most hospitals in Malaysia, clinicians should be aware of the indications and make the necessary referrals to the neuro-optometrist.

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Competing interests

The authors declare that they have no conflict of interests.

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