**The efficacy of Chulalongkorn-Vestibular-Balance-Exercise Program**

**in acute post-operative acoustic neuroma patients**

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# บทคัดย่อ

**วัตถุประสงค์** ศึกษาประสิทธิภาพของ “โปรแกรมกายบริหารจุฬาลงกรณ์ สำหรับผู้ป่วยเวียนศีรษะ/เสียการทรงตัว” ในการเพิ่ม vestibular-compensation ในผู้ป่วยช่วงแรก หลังผ่าตัด Vestibular-schwannoma ที่ 1 เดือน

**วิธีการวิจัย** ผู้ป่วยหลังผ่าตัด Vestibular-schwannoma ถูกสุ่มแบ่งเป็นสองกลุ่ม คือ กลุ่มที่ได้รับการออกกายบริหา และกลุ่มที่ไม่ได้ออกกำลัง

 กายบริหารจุฬาลงกรณ์นี้ เป็นท่ากายบริหารง่ายๆ 5 ขั้นตอน โดยประกอบด้วย vestibular adaptation exercises (x1 viewing paradigm and x2 viewing paradigm)และ habituation exercises โดยหลังผ่าตัด 1 เดือน ผู้ป่วยจะได้รับการประเมินในสองด้าน

• คะแนนอาการเวียนศีรษะ (visual analog score; VAS 0-10)

• Objective measure of imbalance (posturography)

**ผลการทดลอง** ในกลุ่มที่ออกกายบริหาร อาการเวียนศีรษะ หลังผ่าตัด เฉลี่ย 1.3/10 เมื่อเทียบกับกลุ่มไม่ได้ออกกำลัง คะแนนเฉลี่ย 4.5/10 ที่หลังผ่าตัด 1 เดือน ส่วน posturogram ใน condition 5 (use only vestibular clue) เพิ่มขึ้น 23.53% จากกลุ่มไม่ได้ออกกำลัง

**สรุป** กายบริหารจุฬาลงกรณ์ สำหรับผู้ป่วยเวียนศีรษะ/เสียการทรงตัว ช่วยเพิ่ม vestibular compensation ในผู้ป่วยหลังผ่าตัด vestibular schwannoma ที่หลังผ่าตัด 1 เดือน โดย อาการเวียนศีรษะลดลง และการทรงตัวดีขึ้น

# Abstract

Objective

Study the effect of Chulalongkorn-Vestibular-Balance-Exercise Program([1](#_ENREF_1)) in improving vestibular compensation of acute post-operative vestibular schwannoma removal patients at 1 month

Material and Method

 Vestibular schwannoma patients admitted for surgery in King-Chulalongkorn-University-Hospital were recruited. The patients were explained the study prior to surgery and then randomized into 2 groups; Chulalongkorn-Vestibular-Balance-Exercise Group and control Group.

 Chulalongkorn Vestibular Balance Exercise Program simplifies both vestibular adaptation exercises (x1 viewing paradigm and x2 viewing paradigm) and habituation exercises into 5 illustrated, simple steps that can be continued to perform at home after discharge.

Both groups were assessed at 1 month post-operation and compared their scores in 2 aspects

• The subjective symptom of vertigo/disequilibrium (visual analog score; VAS 0-10)

• The objective measure of imbalance (posturography)

Result

 In the exercise group, VAS in vertigo/disequilibrium post-operation was 1.3/10 compared to 4.5/10 in control group at 1 month. Posturogram showed improvement in condition 5 (useก only vestibular clue) increased 23.53% from controls.

Conclusion

Despite its simplicity, Chulalongkorn-Vestibular-Balance-Exercise Program can effectively enhance vestibular compensation, as seen in trend of improvement in patients’ balance status and vertigo/disequilibrium symptoms in post-operative vestibular schwannoma patients at as early as 1 month.

1. PATARAPAK,P. 2010. Chulalongkorn-Vestibular-Balance-Exercise [C.U Vestibular Balance Exercise]. Thai Journal of Otolaryngology Head and Neck Surgery, 11, 128-133.

# Background

 Maintaining balance system, people needs major inputs from three major sources which are vestibular system, visual system, and proprioceptive system. These inputs are modulated by central process in cerebellar and reticular formation. Ultimately, three major outputs of the balance system could be observed which are eye movement(vestibule-ocular reflex), postural control(vestibule-spinal reflex) and perception of balance ([2](#_ENREF_2))

Vestibular deficit in human can come from many etiologies such as acute vestibular neuritis,Meniere disease or acoustic neuroma. Majority of the cases are unexpected loss, which makes preparation for management becomes difficult. However, there are also patients who vestibular loss can be expected such as in post-operative acoustic neuroma patients. Therefore, the loss of vestibular function in these patients is inevitable. These patients are good model in studying vestibular deficit and compensation.

Vestibular compensation is re-balancing the neural activity within the central vestibular system, mainly vestibular nuclei. The signal from other side vestibular nuclei along with visual, spinal, reticular and cerebellar input to the deafferented vestibular nuclei helps to set new balance for the patient.([2](#_ENREF_2))

The rate of vestibular compensation can be expedited by vestibular rehabilitation/exercise. Other factors that can influence in vestibular compensation process are central/cerebellar disorder, vestibular pathology, impairment of vision, psychological problem, age and sex [controversy].([3](#_ENREF_3)) These factors should be control for when validating effectiveness of vestibular exercise.

Vestibular exercise can be divided into 3 types([2](#_ENREF_2))

1. Vestibular adaptation exercise: to stimulate change within vestibular system via input such as retinal image slip.
2. Sensory substitution exercise : to stimulate the use of visual and proprioceptive input clues for patient with impair vestibular function [mainly bilateral vestibular loss]
3. Habituation exercise: to use repetitive movement for reduce the patient symptoms.

Not all type of exercise has good result on post-operative acoustic neuroma patients. ([4](#_ENREF_4)) Habituation exercise may show improvement in patient’s symptom but not in balance objective tests such as posturogram and gait control.([5](#_ENREF_5)) Vestibular adaptation exercise is possible to improve balance as seen in improve posturogram and VOR gain.([6](#_ENREF_6)) For post-operative vestibular schwannoma patients, patient’s symptoms and handicap score were more severe when poorer VOR gain was found.([7](#_ENREF_7))

Chulalongkorn vestibular exercise program was specially designed for enhancing vestibular compensation. The exercise components and instructions were simplified to be easy enough to perform at home.([1](#_ENREF_1)) The exercise consists of both a x1 viewing paradigm and x2 viewing paradigm of vestibular adaptation exercises, which were proven by previous researches to improve outcome in post-operative acoustic neuroma patients.([6](#_ENREF_6), [8](#_ENREF_8)) Not only contain vestibular adaptation exercise, the program also contains habituation exercise. Combination of the two exercises in customized program was proven to improve postural control and disequilibrium symptom in post-operative acoustic neuroma patients.([9](#_ENREF_9)) Therefore, Chulalongkorn vestibular exercise program should be able to improve outcome in these patients as well.

Starting vestibular exercise in acute post-operative stage is important. As shown in monkey after unilateral labyrinthectomy, the monkeys that were restrained for 7 days post-operatively had impaired postural stability and locomotor control when compared with their unrestrained peers. The impairment was evident even after the animals returned to normal activity.([10](#_ENREF_10))

Chulalongkorn vestibular balance exercise program in early post-operative vestibular schwannoma patients should help the patients to compensate or their vestibular loss as shown in improve dizziness symptom and stability.

# Method

## Primary outcome/Hypothesis

 When starting Chulalongkorn vestibular exercise program on post-op Day 3, the subjective symptom of dizziness along with objective measure of imbalance [posturography] should be significantly better than control group.

## Study design

 Randomized controlled trial.

The subjects were randomized into 2 groups : exercise group and control group.

## Participants

* Inclusion criteria
	+ Post acoustic neuroma removal with complete vestibular nerve removal in Kingchulalongkorn memorial hospital
* Exclusion criteria
	+ Bilateral vestibular loss
	+ Contralateral vestibular loss
	+ Age > 70 years old
	+ Severe cervical problem with cervical radicular pain
	+ Partial vestibular nerve resection
	+ Other neurological deficit [other than tumor encroachment to the brainstem and cerebellar]
	+ Severe visual impairment
	+ Severe psychological problem

## Intervention

 Chulalongkorn vestibular balance exercise program ([11](#_ENREF_11)) brochure as enclosed in supplement section was given to the patients in the exercise group. The program consisted of 5 simple steps of exercises. Exercises include vestibular adaptation and habituation exercise.

The exercise program was taught before the surgery about 1-2 days. The patients were explained about each step of the program and practiced the exercise program by themselves at least 2 times before the surgery.

After the surgery on post-operative day3, the patients in examined group were reminded about the exercises. Researcher approached the patients while admitted in the ward. Researcher went through all the exercises with the patients at bedside. Step 1-3 of the exercise were done while admitted for 2 times a day. Step 4-5 of the exercises which involve walking were started after the patients were discharged.

For controls, the patients were advised for routine post-operative care but did not receive the brochure of the exercise program.

## Outcome measure

After the surgery for 1 month, all patients both exercise and control groups were examined in 2 aspects.

### Subjective outcome: visual analog score of vertigo and disequilibrium

 The patients were asked about their vertigo/dizziness/ imbalance symptom. The symptoms were rated on a scale from 0-10, where 0 means no symptom at all and 10 means very severe symptoms.

### Objective outcome: posturogram

 The patients underwent computerized dynamic posturography. They were tested on 6 condition of sensory organization test (SOT) and composite score. The test conditions include a fixed or moving plateform while patients close their eyes, open their eyes and sway-referenced.

## Ethical approval

 This paper had certificate of ethical approval from institutional review board; faculty of medicine Chulalongkorn university. IRB No042/57 (full board review)

# Results

 Total of 5 patients were recruited in the study. The patients were randomized into 2 groups. Exercise group had 3 patients and controls had 2 patients. The demographic data of the 2 groups were shown in table1.

Table 1 demographic data

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Exercise group | Patient | Sex | Age (years) | Side |
| No.1 | female | 43 | Rt |
| No.2 | female | 66 | Lt |
| No.3 | female | 67 | Rt |
| Average |  | 58.67 |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Controlgroup | Patient | Sex | Age (years) | Side |
| No.4 | female | 26 | Lt |
| No.5 | male | 63 | Lt |
| Average |  | 44.5 |  |

The mean age for intervention group was 58.67 years. The mean age for controls was 44.5 years. Intervention group had 3 females while controls had 1 female and 1 male. The sides of the surgery were on the right side for 2 patients in the intervention group and left side for 1 patient. In control group, all patients had the surgery on the left side.

 The subjective visual analog score of vertigo/dizziness and imbalance was recorded for each patient. The average score for exercise group was 1.33 which was lower than controls; average score of 4.5. The bar graph for comparison of the score was shown in figure 1.

Figure 1 subjective visual analog score of vertigo/dizziness and imbalance from 0-10



 After one month, the patient underwent posturogram test. The results for each patient were shown in the table2. The average scores on condition1 to 6 and composite score of patients in the each group were calculated.

The average scores for intervention group were slightly higher than controls in almost all condition except condition3. The different of the average scores of intervention group and controls were ranging from -0.95% to 23.53 %(better than baseline controls). The highest different was in condition5 when intervention groups had average score of 28 compare to controls with average score of 22.67.(23.5% better than controls)

Figure 2 Posturogram scores condition 1-6 and composite score compared between exercise group and controls

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# Discussion

## Patients characteristics

The average age of patients in the intervention group and controls were 58.6years VS 44.5 years. While, there was evidence that age was not affecting the recovery([8](#_ENREF_8), [12](#_ENREF_12)). Some paper still found that age can affect the vestibular compensation process.([3](#_ENREF_3)) In any case, in theory, the intervention group which had higher average age may make them more susceptible to fall or do worse on postural control. However, we found that they were doing slightly better than controls in term of postural control as shown in better posturogram scores. Therefore, we believed that vestibular balance exercise program can help to enhance the patient’s vestibular compensation and postural control.

## Patients symptoms of vertigo/dizziness and imbalance improvement

 Previous research shown that improvement of patient symptoms were seen in habituation exercise alone.([5](#_ENREF_5)) The principle of habituation exercise is straight-forward. By repetitive activity or exercise, the patients get accustom to the dizziness and gradually feel better.

In our study, we also found that patients’ report substantial improvement of symptoms after the exercise. After patients starting to walk as part of the exercise, they gradually experience less and less symptoms over time.

Moreover, our program also consists of vestibular adaptation exercise which was proven to enhance vestibule-ocular reflex gain and patient symptoms.([6](#_ENREF_6))

Therefore, the result of our vestibular balance exercise program in improving patient’s symptoms was already expected by the appropriate combination of exercise and early start of the program.

## Patients postural control improvement

In our paper, almost all conditions of posturogram in the exercise group were better than controls. The most improvement was found in condition5, sway platform with eye close. In condition5, vestibular input is the only input for the patients because we have already eliminated the visual input and proprioception input. So improvement in condition5 of posturogram should indicates improve usage of vestibular input in the patients. This can imply that the patients have better vestibular compensation. This is the reason why in some paper only focus on testing condition5 of posturogram to indicate vestibular compensation after the surgery([5](#_ENREF_5)).

Eventhough, Cohen paper found no improvement in condition 5 posturogram after post-operative vestibular schwannoma patients who did the exercise. We did find improvement in this condition. The reason for this different result should mainly be the intervention program given to the patients. Since, cohen et al gave habituation exercise to the patients (not include vestibular adaptation exercise). Therefore, it is not to our surprise that those patients did not improve in vestibulo-ocular reflex gain nor vestibular compensation.

# Conclusion

 Chulalongkorn Vestibular Balance Exercise Program showed trend in enhance vestibular compensation, as seen in improvement of patients’ balance status and vertigo/disequilibrium symptoms in post-operative vestibular schwannoma patients at as early as 1 month.

# What is already known on this topic?

Post-operative vestibular schwannoma patients usually experience a lot of dizziness from the vestibular loss. Central compensation of the vestibular loss is the process that helps patients to improve the dizziness. This compensation can be enhanced with appropriate vestibular rehabilitation program.

# What this study adds?

The effect of Chulalongkorn vestibular balance exercise in acute post-operative vestibular schwannoma patients was demonstrated. The patients had improvement in both dizziness symptom and postural stability after the exercise for only 1 month.

Further research with more patients is needed to confirm the effect of the program.

# Potential conflicts of interest

None

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