Effectiveness of Chulalongkorn-Vestibular-Balance-Exercise in patients with acute post-operative vestibular schwannoma

Nattawan Utoomprurkporn*
Saowaros Patarapak**

Background : Post-operative patients after removal of vestibular schwannoma usually suffer from dizziness and vertigo. So far, there is no well-established rehabilitation program to help these patients. Chulalongkorn-Vestibular-Balance-Exercise Program is hence designed to as a rehabilitation program that stimulates improvement of the vestibular function. The program should help relieve the undesirable symptoms in these patients.

Objective : To study the effect of Chulalongkorn-Vestibular-Balance-Exercise Program in improving vestibular compensation in patients with post-operative vestibular schwannoma removal at 1 month after the operation.

Methods : Patients with vestibular schwannoma and admitted for surgery at King Chulalongkorn Memorial Hospital were recruited. They were explained about the study and signed their informed consent forms prior to surgery and then randomized into 2 groups: exercise group and control group. Chulalongkorn-Vestibular-Balance-Exercise Program has simplified both vestibular adaptation exercises (x1 viewing paradigm and X2 viewing
paradigm) and habituation exercises into five illustrated, simple steps that can be performed at home after discharge. Both groups were assessed at one month post-operation; their scores were in 2 aspects: the subjective symptom of vertigo/disequilibrium (visual analog score; VAS 0 - 10); the objective measure of imbalance (posturography).

Results : In the exercise group, visual analog score in vertigo/disequilibrium post-operation was 1.3/10 compared to 4.5/10 in control group at 1 month. Posturogram showed improvement in objective measurement in condition 5 (use 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 the trend of improvement in patients’ balance status and vertigo/disequilibrium symptoms in post-operative vestibular schwannoma patients at as early as one month.

Keywords : Post-operative vestibular schwannoma, Chulalongkorn-Vestibular-Balance-Exercise Program.
นัตวรรณ อุทุมพลกุณฑ์, ศาสตรา ภัทรภักดี. ประสิทธิภาพของโปรแกรมกายบริหารจุฬาลงกรณ์สำหรับผู้ป่วยเวียนศีรษะ/เสียการทรงตัวในผู้ป่วยหลังผ่าตัด vestibular schwannoma. จุฬาลงกรณ์เวชสาร 2560 ก.ศ. – ส.ศ.; 61(4): 439 - 49

เหตุผลของการทำวิจัย: ผู้ป่วยหลังผ่าตัดเนื้องอก vestibular schwannoma มักมีอาการเวียนศีรษะเสียการทรงตัวมากในปัจจุบันยังไม่มีวิธีการดูแลการเวียนศีรษะของกลุ่มเหล่านี้ได้อย่างมีประสิทธิภาพสูงสุดและจะต้องการเข้าใจสำหรับผู้ป่วยชาวไทยโปรแกรมกายบริหารจุฬาลงกรณ์สำหรับผู้ป่วยเวียนศีรษะ/เสียการทรงตัวจึงถูกนำมาใช้ในผู้ป่วยกลุ่มนี้เพื่อติดตามการเรียนรู้

วัตถุประสงค์: ศึกษาประสิทธิภาพของ “โปรแกรมกายบริหารจุฬาลงกรณ์” สำหรับผู้ป่วยเวียนศีรษะ/เสียการทรงตัว “ในการเพิ่ม vestibular-compensation ในผู้ป่วยของกลุ่มหลังผ่าตัด vestibular-schwannoma ที่ 1 เดือน

วิธีการทำวิจัย: ผู้ป่วยหลังผ่าตัด vestibular-schwannoma ถูกสุ่มแบ่งเป็นสองกลุ่มคือกลุ่มที่ได้รับการออกกายบริหารและกลุ่มที่ไม่ได้รับการออกกำลังกายบริหารจุฬาลงกรณ์นี้เป็นท่ากายบริหารอย่างง่าย 5 ขั้นตอนโดยประกอบด้วย vestibular adaptation exercises (X1 viewing paradigm and X2 viewing paradigm) และhabitation exercises โดยหลังผ่าตัด 1 เดือน ผู้ป่วยได้รับการประเมินใน 2 ด้าน: คะแนนอาการเวียนศีรษะ (visual analog score; VAS 0 - 10); คะแนนการทรงตัว (posturography)

ผลการศึกษา: ในกลุ่มที่ออกกายบริหารอาการเวียนศีรษะหลังผ่าตัด เฉลี่ย 1.3/10 เนื้อที่กับกลุ่มที่ไม่ได้ออกกำลังคะแนนเฉลี่ย 4.5/10 ที่หลังผ่าตัด 1 เดือน สรุป posturogram ใน condition 5 (use only vestibular clue) เพื่อสัมผัส 23.53 จากกลุ่มที่ได้ออกกำลัง

สรุป: การบริหารจุฬาลงกรณ์สำหรับผู้ป่วยเวียนศีรษะ/เสียการทรงตัวช่วยเพิ่ม vestibular compensation ในผู้ป่วย vestibular schwannoma ภายหลังผ่าตัด 1 เดือน โดยอาการเวียนศีรษะลดลงและอาการทรงตัวยืน

ค่าสำคัญ: โปรแกรมกายบริหารจุฬาลงกรณ์ ผู้ป่วยเวียนศีรษะ/เสียการทรงตัว ผู้ป่วยหลังผ่าตัดเต็มประสิทธิสมองสูงสุดที่ 8.
In maintaining the balance of the head and body, we need major inputs from three sources, namely, the vestibular system, visual system, and proprioceptive system. These inputs are modulated by the central process in cerebellar and reticular formation. Ultimately, the three major outputs form the balance system could be observed which are the eye movement (vestibulo-ocular reflex), postural control (vestibulo-spinal reflex) and perception of balance.\(^1\)

Vestibular deficit in human can come from many etiologies such as acute vestibular neuritis, Meniere’s disease or vestibular schwannoma. The majority of the cases are unexpected loss which makes preparation for management difficult. However, there are also patients who vestibular loss can be expected such as in post-operative vestibular schwannoma 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 the vestibular nuclei. The signal from the vestibular nuclei of the other side along with visual, spinal, reticular and cerebellar inputs helps to set new balance for the patient.\(^1\)

The rate of vestibular compensation can be expedited by vestibular rehabilitation/exercise. Other factors that can influence vestibular compensation processes are central/cerebellar disorder, vestibular pathology, impairment of vision, psychological problem, age and sex [controversy].\(^2\) These factors should be controlled when the effectiveness of vestibular exercise is validated.

Vestibular exercise can be divided into 3 types:\(^1\)

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 demonstrates good result on post-operative vestibular schwannoma patients.\(^3\) Habituation exercise may show improvement in patient’s symptom but not in balance objective tests such as posturogram and gait control.\(^4\) Vestibular adaptation exercise is possible to improve balance as seen in improve posturogram and VOR gain.\(^5\) As for post-operative vestibular schwannoma patients, patient’s symptoms and handicap scores were more severe when poorer VOR gain was found.\(^6\)

Chulalongkorn vestibular exercise program\(^7\) was specially designed to enhance vestibular compensation. The exercise components and instructions have been simplified to be easy enough to perform at home.\(^8\) The exercise itself consists of both a x1 viewing paradigm and x2 viewing paradigm of vestibular adaptation which have been proved by previous researches to improve the outcome in post-operative vestibular schwannoma patients.\(^5,9\) Not only that it contains vestibular adaptation exercise, the program also includes habituation exercise. Combination of the two exercises in customized program has been proved to improve postural control and disequilibrium symptoms in post-operative
vestibular schwannoma patients.\(^{(10)}\) Therefore, Chulalongkorn vestibular exercise program should be able to improve the outcome in these patients as well.

Starting vestibular exercise in acute post-operative stage is important. As shown in monkey models 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 were returned to their normal activities.\(^{(11)}\)

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

The hypothesis was that 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.

Methods

The study design was randomized controlled trial. The subjects were randomized into two groups: exercise group and control group.

The participants were post vestibular schwannoma removal with complete vestibular nerve removal at King Chulalongkorn Memorial Hospital. We excluded patients with 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

The brochure of Chulalongkorn vestibular balance exercise program \(^{(7)}\), enclosed in supplement 1, was given to the patients in the exercise group. The program consisted of 5 simple steps of exercises which include vestibular adaptation and habituation exercise.

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

On post-operative day 3, the patients in examined group were reminded about the exercises. There searcher approached the patients while they were in the ward and went through all the exercises with the patient 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.

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

Outcome measure

After the surgery for 1 month, all patients both exercise and control groups were examined in two 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 six conditions 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.

This study has been approved by the Institutional Review Board (IRB), Faculty of Medicine, Chulalongkorn University. IRB No 042/57 (full board review).

Results

Total of five patients were recruited into the study. The patients were randomized into 2 groups. The exercise group had 3 patients, 2 for the controls. The demographic data of both groups are shown in Table 1.

The mean age for intervention group was 58.67 years. The mean age for controls was 44.5 years. The exercise group had 3 females whereas the control had 1 female and 1 male. Regarding the side of the surgery, two in the exercise group had it on the right, and one patient had on the left. In the control group, both patients had the surgery on the left.

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

Table 1. Demographic data of subjects in this study.

<table>
<thead>
<tr>
<th></th>
<th>Patient</th>
<th>Gender</th>
<th>Age (years)</th>
<th>Side</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise group</td>
<td>No.1</td>
<td>female</td>
<td>43</td>
<td>Right</td>
</tr>
<tr>
<td></td>
<td>No.2</td>
<td>female</td>
<td>66</td>
<td>Left</td>
</tr>
<tr>
<td></td>
<td>No.3</td>
<td>female</td>
<td>67</td>
<td>Right</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td>58.67</td>
<td></td>
</tr>
<tr>
<td>Control group</td>
<td>No.4</td>
<td>female</td>
<td>26</td>
<td>Left</td>
</tr>
<tr>
<td></td>
<td>No.5</td>
<td>male</td>
<td>63</td>
<td>Left</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td>44.5</td>
<td></td>
</tr>
</tbody>
</table>
After one month, the patient underwent posturogram test. The results for each patient are shown in Figure 2. The average scores on condition1 to 6 and composite score of patients in each group were calculated.

The average scores for the exercise group are slightly higher than controls in almost all condition except condition 3. The different of the average scores of the exercise group and controls ranged from -0.95% to 23.53 % (better than baseline controls). The highest difference was in condition5 where in the exercise group had average score of 28 compared to the control with the average score of 22.67 (23.5% better than controls).

Figure 1. Subjective visual analog score of vertigo/dizziness and imbalance from 0 – 10.

Figure 2. Posturogram scores condition 1 - 6 and sensory analysis score compared between exercise group and controls.
Discussion

Patients characteristics

The average age of the subjects in the intervention group and controls were 58.6 years and 44.5 years. There was supporting evidence that age did not affect the recovery. Some papers reported that age can affect the vestibular compensation process. Nevertheless, 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 enhance the patient’s vestibular compensation and postural control.

Patients symptoms of vertigo/dizziness and imbalance improvement

Previous researches have shown that improvement of patient symptoms are seen in habituation exercise alone. The principle of habituation exercise is, however, straight-forward. Through repetitive activities or exercises, the patient gets accustom to the dizziness and gradually feel better.

In our study, we also found that patient reported substantial improvement of symptoms after the exercise. After the patients were 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 has been proved to enhance vestibule-ocular reflex gain and patient symptoms. 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 condition 5, sway platform with eye closed. In condition 5, vestibular input is the only input for the patients because we have already eliminated the visual input and proprioception input. So the improvement in condition 5 of posturogram should indicates improve usage of vestibular input in the patients. This might imply that the patients have better vestibular compensation. This is the reason why in some papers only focus on testing condition 5 of posturogram to indicate vestibular compensation after the surgery.

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 (which did 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.

Limitation

Due to the small sample size of this study, further research with longer recruitment time can contribute to larger sample size. More samples will
enhance the effectiveness of Chulalongkorn vestibular balance exercise program among this group of patients.

Conclusion

Chulalongkorn-Vestibular-Balance-Exercise Program shows a 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 does this study add?

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

Nevertheless, further research with more patients is needed to confirm the effect of the program.

Potential conflicts of interest

None

References


กยารบริหารดุยสางระน (Chulalongkorn Vestibular Balance Exercise)

ขั้นตอนที่ 1 การบริหารกิริยา

- ขั้นตอนที่ 1 หัวศรีษะจากตัวเต็มไปยังหัวตัวด้านซ้าย กลับไปจนถึงตัวเต็มไปยังหัวตัวด้านขวา (ทำต่อๆกันของละ 5-10 ครั้ง)

- ขั้นตอนที่ 2 ก้มศรีษะไปด้านหน้าแล้วก้มศรีษะไปด้านหลัง ซ้ำๆกัน (ทำต่อๆกันของละ 5-10 ครั้ง)

ขั้นตอนที่ 2 การบริหารก้าวคร่าข้างๆ (ภาพปกติ)

- ขั้นตอนที่ 1 ยกขาสูงข้างเดียวอย่างน้อยในระยะทาง 3-5 ฟุต

- ขั้นตอนที่ 2 ในขณะที่สัมผัสกับจุดเด่นที่ I ให้กลับเล็กน้อยด้านข้างไปอย่างน้อย 10-15 ซม. และกลับไปข้างเดียวกัน (ทำคู่กัน 5-10 ครั้ง)

ขั้นตอนที่ 3 การบริหารก้าวคร่าข้างๆ (ภาพปกติ)

- ขั้นตอนที่ 1 ขึ้นขาข้างเดียวไปอย่างน้อยในระยะทาง 3-5 ฟุต

- ขั้นตอนที่ 2 ขึ้นขาข้างเดียวไปอย่างน้อยในระยะทาง 5-10 ฟุต

ขั้นตอนที่ 4 การบริหารก้าวคร่าข้างๆ (ภาพปกติ)

- ขั้นตอนที่ 1 ขึ้นขาข้างเดียวไปอย่างน้อยในระยะทาง 5-10 ฟุต

- ขั้นตอนที่ 2 ขึ้นขาข้างเดียวไปอย่างน้อยในระยะทาง 5-10 ฟุต