Original Article

The Efficacy of Modified Dix-Hallpike Test by Using Pillow Jacket

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Background: Benign paroxysmal positional vertigo (BPPV) causes vertigo in patients. It is the most common type of peripheral vestibular disorder. The patient will have vertigo symptoms while moving the head. The symptoms are usually severe and have duration of seconds.

Objective: To study the efficacy of modified Dix-Hallpike test by using pillow jacket for diagnosis of BPPV patient.

Materials and Methods: The first group was evaluated by using the traditional Dix-Hallpike test and then re-evaluated using the modified Dix-Hallpike test by using pillow jacket, while the modified Dix-Hallpike test was done using pillow jacket and then the traditional Dix-Hallpike test was done in the second group. Patients were assessed for nystagmus using Frenzel glasses recording duration, latency period, and direction of nystagmus. Following completion of the test, each patient was evaluated for pain, ease of use, and level of comfort by using the VAS scale.

Results: Ninety-six patients were recruited into the present study. Forty-eight participants were included in Group 1 using the traditional Dix-Hallpike and then the modified Dix-Hallpike test by using pillow jacket, while forty-five patients were in Group 2 using the modified Dix-Hallpike test by using pillow jacket and then the traditional Dix-Hallpike. There were no significant differences regards to age, gender, laterality, duration of vertiginous symptoms in each attack, or onset of symptoms. No statistical significance was noted in terms of median VAS scores for pain, comfort, or ease of use between the two groups. The sensitivity of the modified Dix-Hallpike test by using pillow jacket was 94.92%, while specificity was 91.43%. McNeMar Kappa tests were equivalent for both the modified Dix-Hallpike test by using pillow jacket and traditional Dix-Hallpike test.

Conclusion: The modified Dix-Hallpike test by using pillow jacket may be reliable, with both high sensitivity and specificity in diagnosing BPPV. This method can be used to assess patients suspected of posterior canal BPPV in cases there is lack of space for head extension, or the patient is unable to change position easily as with the traditional Dix-Hallpike maneuver.

Keywords: Vertigo; Benign paroxysmal positional vertigo (BPPV); Dix-Hallpike test; Modified Dix-Hallpike test

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Vertigo is a common symptom in Thailand. A common disease that causes patients to come to the doctor with vertigo is benign paroxysmal positional vertigo (BPPV)[1]. BPPV causes vertigo in patients. It is the most common type of peripheral vestibular disorder[2]. The patient will have vertigo who often have symptoms while moving the head. The symptoms are usually severe and have duration of seconds. In 1952, Dix and Hallpike[3] described the mechanism of this disease as caused by calcifications in the inner ear and proposed Dix-Hallpike maneuver to induce nystagmus and describe the symptoms of nystagmus, which having direction and specific period of time[4].

The current standard diagnosis of BPPV is Dix-Hallpike maneuver. In 2008, the efficacy of Dix-Hallpike maneuver was studied. BPPV found that the sensitivity value was 79% and specificity was 75%[5].

Other assays for the diagnosis of BPPV were proposed. In 2004, Cohen proposed the side-lying test[6]. In 2016, Pia et al presented Abbreviated Posterior Canalolithiasis Chair-based Assessment Maneuver (APCCAM)[7] and in 2018, Jeon et al presented a modified Dix-Hallpike test with a pillow under shoulders[8].

Materials and Methods

The present study was a prospective randomized controlled trial, single-blind controlled. The present research project had been reviewed and approved from the Human Research Ethics Committee

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Thammasat University (Medicine) (218/2564, MTU-EC-OL-0-187-64) before starting the research. The population of the present study was participant aged 18 to 70 years who were treated at the Ear, Nose and Throat Department of Thammasat University Hospital and were diagnosed with posterior canal BPPV sedimentation (Figure 1). The exclusion criteria were as follows:

1) Patients with neurological disorders.

2) Have been diagnosed with central nervous system disease such as ischemic stroke.

3) Have a history of diagnosis or deformity of the cervical spine or a history of cervical spine surgery before.

4) Patients with body mass index greater than 35 kg/m².

5) Suspected history of combined lateral canal BPPV.

The purpose of the present study was to determine the efficacy of posterior canal BPPV diagnosis using the modified Dix-Hallpike test by using pillow jacket with shoulder and nape support. The participants accepted the present study criteria throughout the diagnosis. There were 93 cases between October 1, 2021 and January 31, 2022, randomly divided into two groups.

Group 1: Forty-eight cases were examined by using Dix-Hallpike test then re-examined using the modified Dix-Hallpike test by using pillow jacket.

Group 2: Forty-five cases were examined by using the modified Dix-Hallpike test by using pillow jacket then re-examined using the Dix-Hallpike.

There was a break of five minutes between the two tests. The examiner recorded data during each test. The examiner recorded the duration of the examination before nystagmus for latency period, duration of nystagmus, and the direction of nystagmus. The examiner was an otolaryngologist who worked in the Department of Otolaryngology, Thammasat University Hospital and had experience with the Dix-Hallpike test and modified Dix-Hallpike test by using pillow jacket. The use of pillow jacket equipment was introduced and practiced before the start of the research to achieve the same testing standards. During the Dix-Hallpike test and modified Dix-Hallpike test by using pillow jacket, the patient wore Frenzel glasses to help the examiner see nystagmus of the patient more clearly.

Examination by modified Dix-Hallpike test by using pillow jacket can be performed by having the patient wear a vest. The device is made of memory foam material, which is soft and lightweight. It is

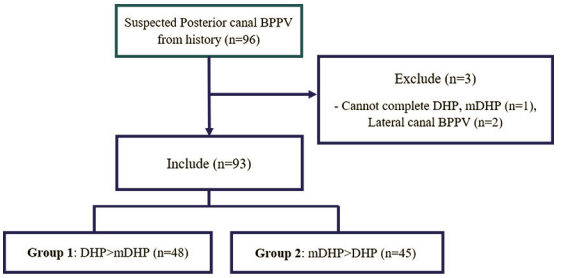

Figure 1. Total of 93 participant met the inclusion criteria.

mDHP=modified Dix-Hallpike test by using pillow jacket; DHP=Dix-Hallpike test; BPPV=benign paroxysmal positional vertigo

Figure 2. The pillow jacket.

designed to support the neck area as it is covered with stretch neoprene fabric and used a four inches PVC pipe to reinforce the area under the pillow to support the weight of the examiner and increase the strength of the equipment (Figure 2). The researchers developed the device, and sewn it onto a vest-like strap, which could adjust the firmness according to the size of the body and arms of the examinee. Such devices could be disassembled for washing. An experiment was done with the pressure weight of the equipment, and it could withstand the weight without breaking or collapsing. When the patient was wearing the device, the patient sat on the examination bed, facing the side to be examined at 45 degrees, then having the patient to lie down with a weight vest on the back and neck. The examiner used his hands to support the neck and face, causing the patient to lie down in a crouched position. When lying down, the patient's shoulder was approximately 10 centimeters higher than the examination bed, causing the patient's neck to bend approximately 20 degrees relatively to the examination bed level (Figure 3).

Table 1. Demographic data

	Group1: DHP>mDHP; median (IQR)	Group2: mDHP>DHP; median (IQR)	p-value
All subject (n=93)			
Number of participants	48	45	-
Age (year)	56 (19.25)	58 (14)	0.18
Sex (male/female)	14/34	7/38	0.14
Time of symptom before diagnosis (day)	6 (12)	7 (10.5)	0.26
Duration of vertigo symptom (minute)	1 (1)	1 (4)	0.41
BPPV patient (n=35)			
Number of participants	17	18	-
Age (year)	59 (13.75)	58 (32)	0.57
Sex (male/female)	5/12	3/15	0.66
Number nystagmus duration in DHP group (case) (1 to 10:10 to 20:20 to 30 seconds)	7:6:2	10:7:0	0.28
Number nystagmus duration in mDHP group (case) (1 to 10:10 to 20:20 to 30 seconds)	12:3:2	10:6:2	0.63
Laterally (right/left)	14/3	11/7	0.12
Onset of symptom before diagnosis (day)	4 (13)	7 (9)	0.56
Duration of vertigo symptom (minute)	1 (1)	1 (6.5)	0.50

mDHP=modified Dix-Hallpike test by using pillow jacket; DHP=Dix-Hallpike test; BPPV=benign paroxysmal positional vertigo; IQR=interquartile range

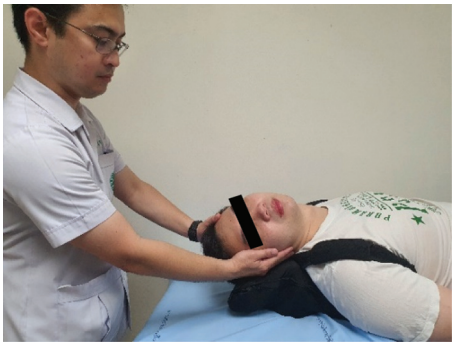

Figure 3. The modified Dix-Hallpike test by using pillow jacket.

Statistical analysis

Statistical analysis of nominal data with two variables was done using Fisher's exact test while more than two variables was done using the chi-square test. Continuous data and normal distribution were analyzed using independent sample t-test. Non-normal distribution data used the Mann-Whitney U test. The quantitative data was segmented using the chi-square test and diagnosis test using t-test dependent. It was calculated using IBM SPSS Statistics, version 25.0 (IBM Corp., Armonk, NY, USA) and the level of statistical significance was set to 0.05.

Results

Demographic data

Assessment of general information and current illness history, gender, age, duration of vertigo symptoms, length of time onset of symptoms until the day of the doctor's visit, associated symptoms, patient's disease, history of previous cervical spine surgery, and drug use history during the past one week were analyzed. There was no statistically significant difference.

The onset of symptoms before hospitalization was not statistically significant different (p-value of 0.26) between the groups. The patients who were diagnosed with posterior canal BPPV in both groups had a median time before the hospitalization and there was no statistically significant difference (p-value of 0.56). For the duration of vertigo, in both groups, the mean time was one minute for vertigo. Furthermore, in both groups diagnosed with posterior canal BPPV, the median duration of vertigo was one minute. The duration of detection of nystagmus, in both groups mostly was between 1 and 10 seconds.

The mean age was not statistically significant different (p-value of 0.18) between the groups. The mean age of the patients diagnosed with BPPV was not statistically significant different (p-value of 0.57). The gender in both groups was not statistically significant different (p-value of 0.14) (Table 1).

The most common associated symptoms were dizziness in 60 cases, followed by nausea and vomiting in 51 cases. In the present study, the most common disease in the patients with vertigo is hypertension among 28 patients, of which 25 patients were hypercholesterolemia and 16 diabetes cases. Thirty-two patients used anti-vertigo drugs regularly

Table 2. Associated symptoms, patient's disease, and medicines used regularly during the past 1 week

Factors	DHP>mDHP; n (%)	mDHP>DHP; n (%)	Total
Associated symptoms			
Headache	11 (12.8)	9 (12.0)	20 (12.4)
Nausea, Vomiting	29 (33.7)	22 (29.3)	51 (31.7)
Tired	8 (9.3)	5 (6.7)	13 (8.1)
Hearing impaired	2 (2.3)	2 (2.7)	4 (2.5)
Dizziness	27 (31.4)	33 (44)	60 (37.3)
Blurry eyes	9 (10.5)	4 (5.3)	13 (8.0)
Patient's disease			
Diabetes	5 (15.6)	11 (20.4)	16 (18.6)
Hypertension	13 (40.6)	15 (27.8)	28 (32.5)
Hypercholesterolemia	12 (37.5)	13 (24.1)	25 (29.1)
Cerebral vascular stenosis	0 (0.0)	1 (1.8)	1 (1.2)
Degenerative cervical	0 (0.0)	1 (1.8)	1 (1.2)
Angina	0 (0.0)	4 (7.4)	4 (4.6)
Other	2 (6.3)	9 (16.7)	11 (12.8)
Medicines used			
Sedative	6 (24.0)	2 (8.7)	8 (16.7)
Anti-vertigo drug	15 (60.0)	17 (73.9)	32 (66.7)
Anti-nausea medication	4 (16.0)	4 (17.4)	8 (16.7)

mDHP=modified Dix-Hallpike test by using pillow jacket; DHP=Dix-Hallpike test

during the past one week including eight with sedative and anti-nausea medication (Table 2).

Assessment of the sensitivity and specificity of modified Dix- Hallpike test by using pillow jacket was 91.43% and 96.55% (Table 3), respectively. Kappa coefficient was 0.86 indicating the consistency of the results was almost perfect[9] (Table 4).

When evaluating discomfort, pain, and easiness of performance at the time of examination in both groups, there was no statistically significant difference in the VAS scale. The group that received the modified Dix-Hallpike test by using a pillow jacket (group 2) had better examination comfort and less pain, but there was no statistically significant difference (Table 5).

Discussion

The diagnosis of posterior canal BPPV with physical examination using the Dix-Hallpike maneuver can reveal torsional upbeat nystagmus[10]. Therefore, the researcher invented a vest device with shoulder and nape support to support the patient's neck during an examination. Using such a device, the examiner can examine the correct posture by using the hands to support the weight of the neck downwards. As a result, the examiner can concentrate more on the examination and interpretation of the results from viewing nystagmus in the patient's eyes.

However, there is no research on the efficacy in diagnosing BPPV with a modified Dix-Hallpike test by using a pillow jacket. From the results of this research, it was found that the sensitivity and specificity of the modified Dix-Hallpike test by using

Table 3. Sensitivity and specificity of modified Dix-Hallpike test by using pillow jacket

mDHP	DHP		Total
	Positive	Negative	
Positive	32	2	34
Negative	3	56	59
Total	35	58	93
Statistic	Cohen's kappa 0.86 (p<0.01)		
	Sensitivity of mDHP 91.43% (95% CI 76.94 to 98.20)		
	Specificity of mDHP 96.55% (95% CI 88.09 to 99.58)		

mDHP=modified Dix-Hallpike test by using pillow jacket; DHP=Dix-Hallpike test; CI=confidence interval

Table 4. Kappa coefficient

Kappa statistic	Strength of agreement
<0.00	Poor
0.00 to 0.20	Slight
0.21 to 0.40	Fair
0.41 to 0.60	Moderate
0.61 to 0.80	Substantial
0.81 to 1.00	Almost perfect

Table 5. VAS score of DHP and mDHP

	Discomfort		Pain		Easiness	
	Median (IQR)	p-value	Median (IQR)	p-value	Median (IQR)	p-value
Total individuals						
DHP						0.79
• DHP>mDHP	3 (2.75)	0.43	2 (4)	0.44	3 (2)	
• mDHP>DHP	3 (2)		3 (2.5)		3 (2)	
mDHP						0.71
• DHP>mDHP	2 (3)	0.55	2 (2.50)	0.14	2 (1.75)	
• mDHP>DHP	2 (2)		2 (2)		2 (1)	
BPPV patients						
DHP						0.82
• DHP>mDHP	3 (3)	0.40	3 (3)	0.77	2 (2)	
• mDHP>DHP	3 (4)		3 (4.5)		3 (2)	
mDHP						0.73
• DHP>mDHP	2 (3)	0.64	2 (4)	0.57	2 (2)	
• mDHP>DHP	2 (1)		2 (2.5)		2 (2)	

mDHP=modified Dix-Hallpike test by using pillow jacket; DHP=Dix-Hallpike test; BPPV=benign paroxysmal positional vertigo; IQR=interquartile range

pillow jacket is 91.43% and 96.55%, respectively, compared to the examination by Dix-Hallpike maneuver. In addition, the Kappa coefficient at 0.86 indicates the consistency of the results of the modified Dix-Hallpike test by using a pillow jacket as compared with the Dix-Hallpike test, which was consistent or almost perfect.

However, three patients assessed by modified Dix-Hallpike test by using pillow jacket tested negative while the examination with Dix-Hallpike maneuver found that there was nystagmus. Therefore, if a patient is examined by a modified Dix-Hallpike test by using a pillow jacket and the result is negative for nystagmus, there may be a need to do the Dix-Hallpike maneuver to confirm the results. Two patients tested positive by modified Dix-Hallpike test by using pillow jacket but negative when assessed by Dix-Hallpike maneuver. This may be due to the presence of fatigability, a common feature of BPPV that, upon repeated examination, may result in decreased or negative nystagmus.

Conclusion

In terms of comfort assessment, pain, and easiness to perform, there was no statistically significant difference in the VAS scale between the two groups. However, the modified Dix-Hallpike test by using a pillow jacket in the BPPV group had better examination comfort and the less pain value as compared to the Dix-Hallpike maneuver.

Diagnosis of BPPV with a modified Dix-Hallpike test by using a pillow jacket is an alternative and reliable method of examination. The examiner can perform this examination even if the examination bed or the examination area is not suitable for the normal Dix-Hallpike maneuver.

What is already known on this topic?

The current standard diagnosis of BPPV is Dix-Hallpike maneuver.

What this study adds?

The modified Dix-Hallpike test by using pillow jacket it is an alternative method of examination that is reliable.

Conflicts of interest

The authors have no conflicts of interest to declare.

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