ความแม่นยำของการทดสอบ Side-lying ในการวินิจฉัยโรคเวียนศีรษะ

Benign Paroxysmal Positional Vertigo

นางเสาวรส อัศววิเชียรจินดา

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DIAGNOSTIC ACCURACY OF SIDE-LYING TEST FOR DIAGNOSIS BENIGN PAROXYSMAL POSITIONAL VERTIGO (BPPV)

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เสาวรส อัศววิเชียรจินดา : ความแม่นยำของการทดสอบ Side-lying ในการวินิจฉัยโรคเวียนศีรษะ Benign Paroxysmal Positional Vertigo (BPPV) (Diagnostic Accuracy of Side-lying test for diagnosis Benign paroxysmal positional vertigo) อ.ที่ปรึกษา: ศ.นพ.อนันต์ ศรีเกียรติขจร, อ.ที่ปรึกษาร่วม: ศ.นพ.กัมมันต์ พันธุมจินดา, จำนวนหน้า 64 หน้า. ISBN 974-14-2130-3

วัตถุประสงค์ : เพื่อศึกษาความแม่นยำของการสอบ Side-lying ในการวินิจฉัยโรคเวียนศีรษะชนิด Benign paroxysmal positional vertigo โดยเปรียบเทียบกับการทดสอบมาตรฐาน Dix-Hallpike

รูปแบบการวิจัย : เปรียบเทียบความถูกต้องของการทดสอบกับวิธีมาตรฐาน

สถานที่ทำการวิจัย : คลินิกเวียนศีรษะและการได้ยิน ภาควิชาโสต ศอ นาสิกวิทยา คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

วิธีการศึกษา : ผู้ป่วย 86 ราย ที่มีอาการเวียนศีรษะไม่มากกว่าหนึ่งเดือน ได้รับการตรวจร่างกาย แล้วตรวจทดสอบโดยวิธีมาตรฐาน (Dix-Hallpike) และวิธีทดลอง (Side-lying) ภายใต้เครื่องมือ computerized video electronystagmography ผู้ทดสอบบันทึกอาการแทรกซ้อนในระหว่างการทดสอบถ้ามีหลังจากนั้นคำนวณค่าผลลัพธ์ของการทดสอบเปรียบเทียบกับวิธีมาตรฐาน

ผลการศึกษา : ในจำนวนผู้ป่วยที่เข้าร่วมโครงการ 86 ราย (หญิง 60 ราย, ชาย 26 ราย) อายุระหว่าง 17-79 ปี (เฉลี่ย 54.1 ปี) อัตราของโรคที่พบในกลุ่มทดลองเท่ากับ 57 เบอร์เซ็นต์ ค่าความไวของการทดสอบ Side-lying เท่ากับ 89.8 เปอร์เซ็นต์ ความจำเพาะเท่ากับ 89.2 เปอร์เซ็นต์ ความแม่นยำของการทดสอบเท่ากับ 85.5 เปอร์เซ็นต์ ค่า positive predictive value เท่ากับ 91.7 เปอร์เซ็นต์ ค่า negative predictive value เท่ากับ 86.8 เปอร์เซ็นต์ และค่า Likelihood ratio เท่ากับ 8.3 เมื่อเทียบกับการทดสอบมาตรฐาน Dix-Hallpike ไม่พบความแตกต่างอย่างมีนัยสำคัญในเรื่อง ผลข้างเคียงของการทดสอบ เมื่อมีการวิเคราะห์แยกกลุ่มตามอายุ พบว่าในกลุ่มอายุมากกว่า 50 ปี มีอัตราชุกของโรคสูงกว่าในกลุ่มอายุน้อยกว่า 50 ปี นอกจากนี้พบว่าค่าความไวของการทดสอบสูงกว่าในกลุ่มอายุมากกว่า 50 ปี ซึ่งต่างจากค่าความจำเพาะที่สูงกว่าในกลุ่มอายุน้อยกว่า 50 ปี

สรุป : การตรวจวินิจฉัยโรค benign paroxysmal positional vertigo โดยการทดสอบ Side-lying test มีความไวสูง และความจำเพาะสูง เมื่อใช้การทดสอบ Dix-Hallpike เป็นมาตรฐาน การทดสอบ Side-lying สามารถเป็นตัวเลือกการตรวจวินิจฉัยโรคเวียนศีรษะชนิด BPPV ได้อีกทางเลือกหนึ่ง

สาขาวิชา การพัฒนาสุขภาพ ลายมือชื่อ นิสิต.....

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ลายมือชื่อ อาจารย์ที่ปรึกษาร่วม.....

477 50099 30: MATOR HEALTH DEVELOPMENT

KEY WORD : BPPV, DIX-HALLPIKE MANEUVER, SIDE-LYING TEST, VERTIGO

SAOWAROS ASAWAVICHIANGINDA: DIAGNOSTIC ACCURACY OF SIDE-LYING TEST FOR BENIGN PAROXYSMAL POSITIONAL VERTIGO. THESIS ADVISOR: Professor Anan Srikiatkhachorn, M.D., M.Sc., THESIS CO-ADVISOR: Professor Kamman Phanthumchinda, M.D., M.Sc., 64 PAGES, ISBN 974-14-2130-3

Objective: To determine sensitivity, specificity, likelihood ratio of side-lying test for diagnosis Benign paroxysmal positional vertigo when compare to Dix-Hallpike test

Design: A diagnostic cross-sectional study

Setting: Dizziness and hearing clinic, Department of Otolaryngology, Faculty of Medicine, Chulalongkorn University

Method: Eighty-six dizzy patients, who experience vertigo not more than one month were assessed for having benign paroxysmal positional vertigo (BPPV). Both Dix-Hallpike maneuver and side-lying test were done under the computerized video electronystagmography. The diagnostic performance of side-lying test was analyzed using Dix-Hallpike test as the gold standard. During the procedure, the examiner recorded for the adverse events.

Result: There were 86 patients (60 females, 26 males) enrolled into the study with age range from 19 to 79 (mean 54.1 yrs) years. The prevalence of BPPV in this study was 49 (57%). Sensitivity was 89.8% (81.3-98.6), specificity was 89.2% (79.2 - 99.2), accuracy was 85.5%, positive predictive value, negative predictive value and likelihood rotio were 91.7%, 86.8% and 8.3 accordingly. There was no significant difference in adverse events. Subgroup analysis shows more prevalence rate in higher age. The sensitivity is also higher in older group, incontrast to specificity which was extremely high in younger age group.

Conclusion: Side-lying test had relatively high diagnostic performance for diagnosis benign paroxysmal positional vertigo when us Dix-Hallpike maneuver as a gold standard. Side-lying test may be an alternative for diagnosis BPPV.

Field of study Health Development.....Student's signature.....

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CHAPTER I
INTRODUCTION

RATIONALE AND BACKGROUND

Positional vertigo is a common symptom that usually indicates a benign inner ear disorder. The most common variety, is benign paroxysmal positional vertigo (BPPV). BPPV is a clinical condition characterized by transient episodes of vertigo when the affected ear is in the dependent position. Although first described by Barany in 1921,[1] the specific characteristics of this disorder were defined in 1952 by Dix and Hallpike who advised a positioning maneuver to diagnose BPPV.

Among patients seen in a general internal medicine outpatient clinic[2] and in subspecialty dizziness clinics,[3,4] vertigo was the most frequent category of dizziness, and BPPV was the most common cause of vertigo. Symptoms of BPPV are triggered by head movement. Most of the episodes occur when the patient gets in and out of bed, leans back, bends over, or looks up.[5] The estimate incidence of BPPV is 160,000 new cases per year in the United state.[6]

BPPV has long been recognized, only recently has its underlying pathophysiology been clarified and substantiated.[7,8,9] Free-floating particulate matter with the posterior semicircular canal of the vestibular labyrinth has been observed in vivo in several patients with this disorder.[9,10] This finding led to the development of an innovation bedside treatment in which the free-floating particles are moved from the posterior semicircular canal to another location within the vestibular labyrinth.[6,11,12] This maneuver provide the patient with immediate, and long-lasting, relief from vertigo.[13,14]

BPPV has a significant impact on health-related quality of life and particle repositioning maneuver improves health-related quality[15] of life a lot. Therefore, the diagnosis of BPPV or differentiation BPPV from the other causes of dizziness is very important. BPPV is characterized by positional vertigo and by positional nystagmus elicited by head-hanging maneuver, usually called the Dix-Hallpike maneuver.[15,16,17] The Dix-Hallpike maneuver is widely used in the diagnosis of BPPV. The diagnosis is based on findings of typical positional rotatory nystagmus provoked by the head-hanging position and the observation of certain characteristic features including a brief latency (usually 1 to 5 sec), limited duration (usually < 60 sec), reversal on assuming an upright position and a fatiqueing of the response on repeat testing. In the head-hanging left-ear down position, the nystagmus occurs in a clockwise direction, on the head-hanging right ear down position, the direction is counter clockwise.

Although Dix-Hallpike maneuver has several advantages, this maneuver also has some disadvantages. Many patients have difficulty relaxing enough to allow brisk passive movement of the head backward for fear of eliciting vertigo. The maneuver needs cervical range of motion. In a case of musculoskeletal limitation or obesity it is very difficult to perform and in some neck condition it may be contraindicated. Moreover, the biomechanics of the maneuver could strain the clinician's back. An alternative test to use for diagnosis BPPV with comparable result will be beneficial for patients with limited range of neck motion or who are contraindicated for Dix-Hallpike maneuver.

To produce positioning nystagmus, one must understand the mechanism of how nystagmus is evoked. The lateral head-trunk tilt or side-lying maneuver is another way to stimulate the inner ear balance organ thus producing nystagmus. This maneuver stimulates the posterior semicircular canal by similar biomechanics. However, the validity and the usefulness of the maneuver have not been clearly demonstrated.

The purpose of this study is to assess the diagnostic performances i.e. sensitivity, specificity, likelihood ratio and other diagnostic property of side lying test regard to the gold standard Dix-Hallpike test for diagnosis BPPV.

CHAPTER II
REVIEW OF LITERATURES

Benign paroxysmal positional vertigo (BPPV) is the most common cause of vertigo, particularly in elderly. This condition is characterized by brief attacks of rotatory vertigo and concomitant positioning rotatory nystagmus which are elicited by rapid changes in head position relative to gravity.[18] It is common after colds, trauma, surgery, ear infections and is seen frequently in association with other inner ear disorders. However, many cases are idiopathic.

Epidemiology

BPPV had been said to be the most commonly recognized peripheral vestibular disorder. In one cohort study, the mean age at onset was 54 years, with a range of 11 to 84 years.[17] Froehling et al, estimated that the incidence is as high as 107 cases per 100,000 population per years.[2] Another study in Japan in which patients were considered to have benign paroxysmal positional vertigo only if had nystagmus during a Dix-Hallpike test found an incidence of 10.7 cases per 100,000 per year.[19] In another report by Katsarkas and Kirkham[15], the mean age of their 255 patients was 50 years, in the 240 patients described by Baloh and colleagues,[17] reported that the prevalence of BPPV in their dizziness clinic increased with advancing age.[20]

The prevalence of BPPV according to our previous study in Dizziness and Hearing clinic, Department of Otolaryngology, Faculty of Medicine, King Chulalongkorn Memorial Hospital was approximately 40 percent of all dizzy patients visited to clinic.[30]

There was some sex predominance in the study reported by Baloh and his collegues. They found female outnumbered males by a ratio of 1.6:1 combining all diagnostic categories. This ratio was approximately 2:1 if one considers only the idiopathic and miscellaneous groups.

Cohort study, in Olmsted country, Minnesota, gender was not significantly associated with the incidence of BPPV. The age-adjused incidence for women was 75 per 100,000 populations and that for men was 50 per 100,000.[6]

Pathophysiology

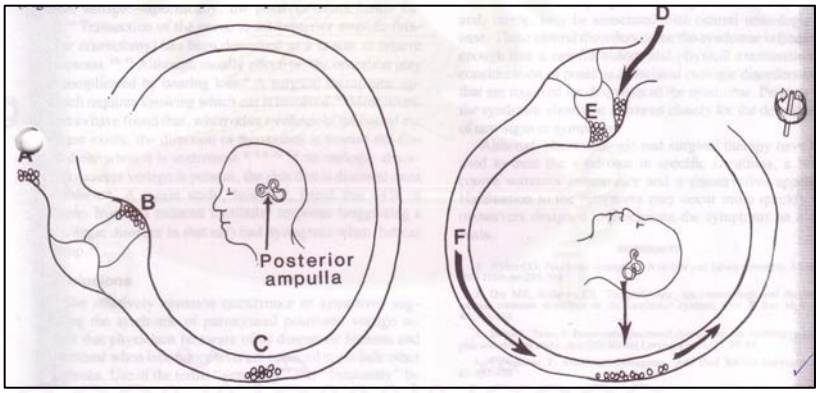
The mechanism creating the typical phenomena of nystagmus has long been a source of speculation. Dix and Hallpike described that in the majority of BPPV cases nystagmus occurred when the affected ear was placed undermost in the provocative position. This verified that the labyrinth is the origin of this mechanism.

There are two theories regarding to pathophysiology of BPPV. Cupulolithiasis and canalithiasis. Cupulolithiasis theory by Schuknecht who discovered basophilic particle or densities that were adherent to the cupula and postulated that the posterior semicircular canal (PSC) was rendered sensitive to gravity by these abnormal dense particle.[3,4] The posterior semicircular canal localization of this theory was verified in 1974 by the success of Gacek's singular neurectomy[21] but the heavy (adherent) copular has been brought into question for several reasons. Most important, physiologic principles dictate that gravity dependent defection of a cupular would continue as longe as the provocative orientation was maintained, thus evoking sustained nystagmus. This has been demonstrated by studies in which a density differential is created between the endolymph and the cupula by ingestion of alcohol or deuterium, resulting in nystagmus which is lasted for hours while the provocative head position is maintained.[22] In contrast, nystagmus in BPPV persists for only a few seconds and then abruptly ceases. So, this means that nystagmus of BPPV is not generated directly by the effect of gravity on a heavy cupula.

Another theory is canalithiasis. Hall et al. in 1979 proposed that those BPPV subjects that demonstrate response decline with repetitive provocation are due to free densities in the endolymph[7], In 1980 Epley indicated that the phenomena observed in patients with nystagmus were explainable by the presence of free floating particle in

the PSC created by gravity while the head is tilted backward, the particles are rotated up approximately 90 degree along the arm of the PSC. These cause the endolymph to flow away from the cupula and causes the cupula to be deflected and produces nystagmus.[8,9,10]

Pathophysiology of provocative position. When the head is moved to the tested position, the debris begin gravitating as a bolus. This well lead to an ampullofugal, thus depolarization occur. A few seconds are required for the drug to overcome the inertia and resistance of the endolymph within the canal and the elasticity of the cupula. This will lead to some latency before the rotatory nystagmus occurs. And when the canaliths stop gravitating or the drag on the endolymph ceases, elasticity returns the cupula to its neutral position, and the nystagmus and vertigo cease. So this call limited duration. During the simulation period the torsional nystagmus with its axis generally parallel to the axis of the PSC and its fast phase directed toward the undermost ear. (typical rotatory nystagmus) (fig 2.1)



Fog 2.1 pathophysiology of provocative position

Clinical Manifestation [11,12,22,13]

BPPV patients generally have two components of clinical symptom. The most initial symptoms at the onset is positionally induced vertigo without cochlear symptoms, such as tinnitus and hearing impairment. Positional vertigo was induced by moving the head. The classic scenario is an intense brief episode of spinning when getting up or lying down and also rolling over in bed. Vertigo also commonly occurs in a lesser degree when the patient is gazing upward or bending forward. The first attack of

vertigo is often severe and associcated with nausea, with or without vomiting. An unexpected intense vertigo at the initial onset may be frightening and may bring BPPV patient to an immediate visit at the emergency room. The duration of the vertigo is commonly short (no more than 60 seconds) but to many patients it feels like much longer. The interval between episodes many rang from hours to years.

The second component of symptoms is disequilibrium that is reported with movements. Some BPPV patients will present that they feel drunk when trying to walk with sensation they are going to fall to one side. They may sometimes say that they have noticed the phenomenon of adaptation and can make their dizziness to disappear by avoiding their head from provocative position.

One symptom of interest is of discomfort, and it may be of tenderness in the affected occipital region. However, this symptom is only presented in some cases.

Differential Diagnosis

The differential includes positional nystagmus of central origin, vestibular neuronitis, Meniere's disease, perilympathic fistula and autoimmune inner ear disease.

The characteristic of other common vestibular disorder are shown in table 2.1

Table	Characteristics of Common Fluctuating Vestibular Disorders						
Diagnosis	Duration of Rotatory Vertigo	Vetigo with	Hearing Loss	Aural Fullness	Fluctuating Hearing	Tinnitus	Trauma
BPPV	<Minute	Position changes	None	None	None	None	Sometimes
Meniere's	Hours	No association	Usually unilateral	Usually	Usually	Usually	No
PLF	Minutes-hours	Physical straining	Sometimes unilateral	Sometimes	Sometimes	Sometimes	Usually
AIED	Hours	No association	Progressive bilateral	Sometimes	Sometimes	Sometimes	None

Table 2.1 Characteristic of common fluctuating vestibular disorders

It is also important to consider whether the position vertigo and nystagmus is idiopathic or occurring in associated with central nervous system.

From the report by Mohr[6], none of the 100 patients described by Dix-Hallpike test had central pathologic lesions.

Etiologic Factors

The major factors apparently predispose a person to have BPPV are: advanced age, trauma, inactivity and other ear diseases.

Most of the report in literatures review, noted that the average age of BPPV patient is above 50. This is probably related to the shedding of otoconia from the utricular macula that starts with middle age. This process can be accelerated by an untoward event such as trauma or infarction including ear surgery, severe head acceleration or deceleration such as whiplash injury or high-impact exercises.

BPPV had been reported after condition such major surgery, acute alcoholism and central nervous system disease, in which the common denominator is prolong inactivity of the head.

Last factor, 20 percent of BPPV is concomitant ear pathology, usually involving other manifestations of inner ear trauma.

Clinical Evaluation and Diagnosis.[6,24,26,28]

A diagnosis of benign paroxysmal positional vertigo can be established definitively by the Dix-Hallpike Maneuver. The physical exam in BPPV patients is generally normal with the exception of this test. The Dix-Hallpike test is performed by having the patient lie prone with the head turned approximately 45 degrees to the side being tested and slightly hanging over the edge of the examining table. During this, the eye are observed for nystagmus. A normal exam should demonstrate no evidence of nystagmus, and the patient should experience no vertigo. The diagnostic criteria includes the occurrence during the Dix-Hallpike test of a characteristic mixed torsional and vertical nystagmus with the upper pole of the eye beating toward the dependent ear and vertical nystagmus beating toward the forehead.

The presence of BPPV will elicit vertigo and nystagmus with five major characteristics :

1. latency of onset, usually 2-6 seconds
2. short duration, usually less than 30 seconds
3. reversibility
4. fatigability
5. direction (torsional)

Throughout the abnormal Dix-Hallpike test, BPPV patient will be fine at the beginning when getting to the prone position, but after a short latency period of 2-6 seconds, the nystagmus will occur. At the same time, the feeling of spinning will occur if nystagmus presented. The nystagmus and vertigo may last anywhere from a few

seconds to a minute. The nystagmus is rotatory movement of the eyes. For those BPPV of right ear will exhibit nystagmus with a fast phase in the counterclockwise direction (geotropic nystagmus, upper pole of the eye moving toward the ground). For those BPPV of left ear, the fast phase of the nystagmus is in the clockwise direction (geotropic nystagmus).

The reversal of nystagmus can be demonstrated when patient is bought back to the upright position, but usually in milder degree. This is called reversibility (ie. If patient has right side BPPV, the right Dix-Hallpike test would produce a counterclockwise nystagmus. When patient is brought back to the upright position, he will have clockwise nystagmus of lesser degree).

Repeated Dix-Hallpike test will result in progressively milder degree of both nystagmus and vertiginous symptom. This is called fatigability. If Dix-Hallpike test was repeated one can see less intense of nystagmus and less severe of vertigo. By the third or fourth repetition, the Dix-Hallpike test will demonstrate no evidence of nystagmus and patient will no longer note vertigo.

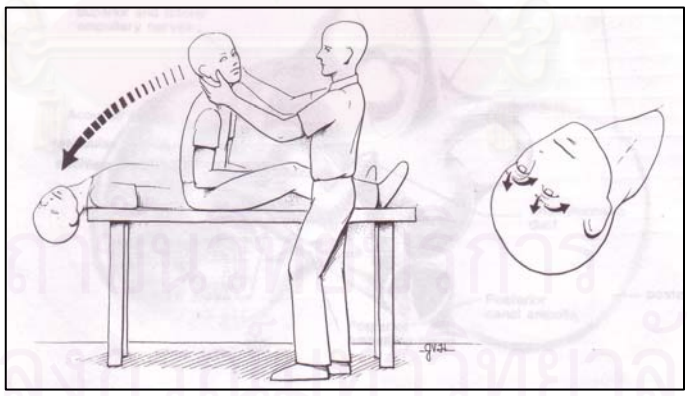


Fig 2.2 Dix Hallpike test

The steps for a correct diagnosis of BPPV is base on typical history of positional rotatory vertigo, postural imbalance and also the presence of a reproducible vertigo and paroxysmal positioning nystagmus by Dix-Hallpike test which should be performed under Frenzel's glasses or during electronystagmography. A precise diagnosis is very

important in view of specific treatment of this type of vertigo by rehabilitation theraphy.[24]

Advantages of Dix-Hallpike maneuver

This maneuver has several advantages. One examiner can perform it easily. The eye movement can be recorded through electro-or video-oculography, or simple observed using Frenzel glasses.

Disadvantages of Dix-Hallpike maneuver

This maneuver also has some disadvantages. First, many patients have difficulty relaxing enough to allow brisk passive movement of the head backward for fear of eliciting vertigo. Secondly, the patient need cervical range of motion within functional limits and enough range in the trunk and hips to lie supine. Many patients are difficult to test as a result of musculoskeletal limitation or obesity. Lastly, the biomechanics of the maneuver could strain the clinician's back.

Contra indication for Dix-Hallpike maneuver

Limitations in passive or active range of motion preclude testing some patients suspected of BPPV with Dix-Hallpike maneuver includes.[28,29]

a) Severe cervical sponlylosis
b) Post cervical injury or operation
c) Cervical instability
d) Musculoskeletal limitations ie. rheumatoid arthritis, obesity
e) Relative contraindication in vertebrobasilar insufficiency

Analysis Data from Thai Physician [30]

Analysis of the survey data from Thai physicians during the contemporary management strategies for vertigo meeting, in 2004 revealed that most of physicians (including otolaryngologists, neurologists, and family doctors) felt uncomfortable with Dix-Hallpike test in those especially with severe cervical spondylosis or undergone cervical spine injury or operation. They also commended on the limitation of Dix-Hallpike test which need well trained physicians (42 percent). Ninety percent of physicians looked forward to another more comparable test. (test 2.2)

Table 2.2 the opinion of Thai Physicians regard to Dix-Hallpike test.

Reason not doing Hallpike maneuver

	Frequency	Percent
Never be trained	1	3.85
Too difficult, take long time	21	80.77
Afraid of complication	4	15.38
Tatal	26	100.00

Limitation of Dix-Hallpike test

	Frequency	Percent
Can be use only well trained ENT	21	42.00
Can be use generally	25	50.00
Too complicate, should have another test instead	4	8.00
Total	50	100.00

Contraindication of Dix-Hallpike test

	Frequency	Percent
Severe cervical spondylosis	11	40.74
Vertebral-basillar insufficiency	1	3.70
Recent cervical injury or operation	15	55.56
Total	27	100.00

If there is another test can be used instead of Dix-Hallpike test

	Frequency	Percent
Agree	16	31.37
Agree if sensitivity and specificity have been test	30	58.83
Disagree (Dix-Hallpike test is complete do not need another test)	5	9.80
Total	51	100.00

Laboratory recordings

Rotatory eye movement during Dix Hallpike test cannot be directly identified by electronystagmography (ENG). Because ENG detects eye movement centering on the dipole through the pupil, the tracing pattern of the nystagmus varies with the gaze positional of the pupil. The horizontal channel tracing of nystagmus in the BPPV patient shows the fast phase directed toward the uppermost ear whenever the volitional pupillary position is inferior to the axis of rotation. However, the nystagmus of BPPV subject is more rotatory component that is very difficult to record by ENG. So the ENG is not recommend to be a standard laboratory recording. Infrared videoelectronystagmography is more useful for the test. The eyes can be recorded directly through this method.[24,26,27]

Side-lying test

Although Dix-Hallpike test is the gold standard test for BPPV. This maneuver has several disadvantages and there is some contraindication to perform this. The need for alternative test that is more simple to perform, adaptable for patients with limited range of motion or who has difficulty relaxing. The Side-lying test or Side-lying maneuver which also stimulates the posterior semicirlar canal using different biomechanics is performed by briskly laying the patient on the side. (fig 2.3)

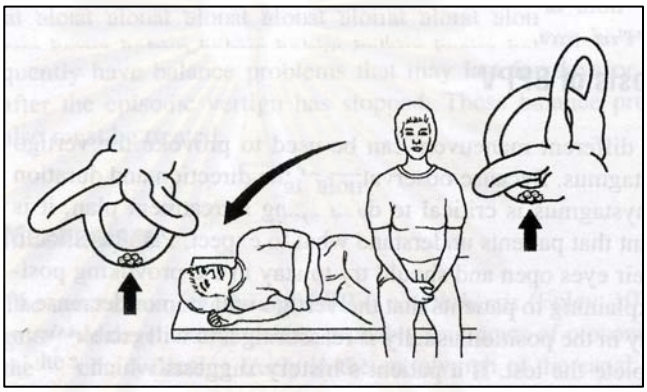


Fig 2.3 Side lying test

There is only one study that compare the side-lying test and Dix-Hallpike test.[29] In this study only 29 BPPV patients are reviewed from 61 study subjects. These was no mention why others were drop out. The technique used in this study was ENG (Electronystagmography) and the timing of each test (Side-lying and Dix-Hallpike was only 5 minutes). Also, There was no statistic report concerning the accuracy of the Side-lying test (ie. Sensitivity, specificity, likehood ration) as recommend by the STARD statement for reporting studies of diagnosis test.[31]

Therapy for Benign Paroxysmal Positional Vertigo [5,11,12,13,14]

Vestibular habituation exercise or the repositioning therapy are an effective treatment for patient with typical BPPV. Pharmacologic treatment with vestibular suppressant is generally ineffective.[32] Surgical interventions-singular neurectomy and posterior semicircular canal occlution are effective, but are reserved for patient with intractable conditions who do not respond to conservative treatment.[33,34]

There are three basic repositioning therapy for BPPV, each with its own indications for use : canalith repositioning, Liberatory and Brandt-Daroff habituation exercise (Epley, 1992 ; Semon et al, 1988; Brandt and Daroff, 1980). Many studies on the efficacy of these treatment demonstrated that all three treatment facilitate recovery.

Canalith repositioning Procedure (CRP)

This therapy is based on the theory of canalithiasis that the transient nystagmus is exclusively caused by densities moving freely in the endolymph of a semicircular canal. CRP was instituted at the Portland Otologic clinic in 1979 as the treatment of choice for BPPV. The rational of CRP is depend on the moving of the debris (canaliths) particle to migrate by gravitation completely out of the PSC, by way of the common crus, to the utricle, where they no longer would affect the dynamics of the semicircular canals. The timing of CRP is based on ongoing observation of the induced nystagmus by Dix Hallpike test, which reflects the direction and rate of induced canalith migration. An oscillation device is applied throughout the procedure to minimize adherence of the canaliths and decrease their angle of repose relative to the side walls of the semicircular canal. The 5 position cycle for treatment of BPPV with classic nystagmus is illustrated in fig 2.4 This procedure is repeated until no nystagmus is observed during the last cycle, or until no progress is apparent in the last two cycles.

Epley's initial publication on the use of bedside treatment for BPPV reported an 80 percent success rate after a single treatment an a 100 percent success rate when there was more than one treatment session. Other following clinical trial reported success rate that rang from 44 percent to 88 percent.[5,11,14,35,36]

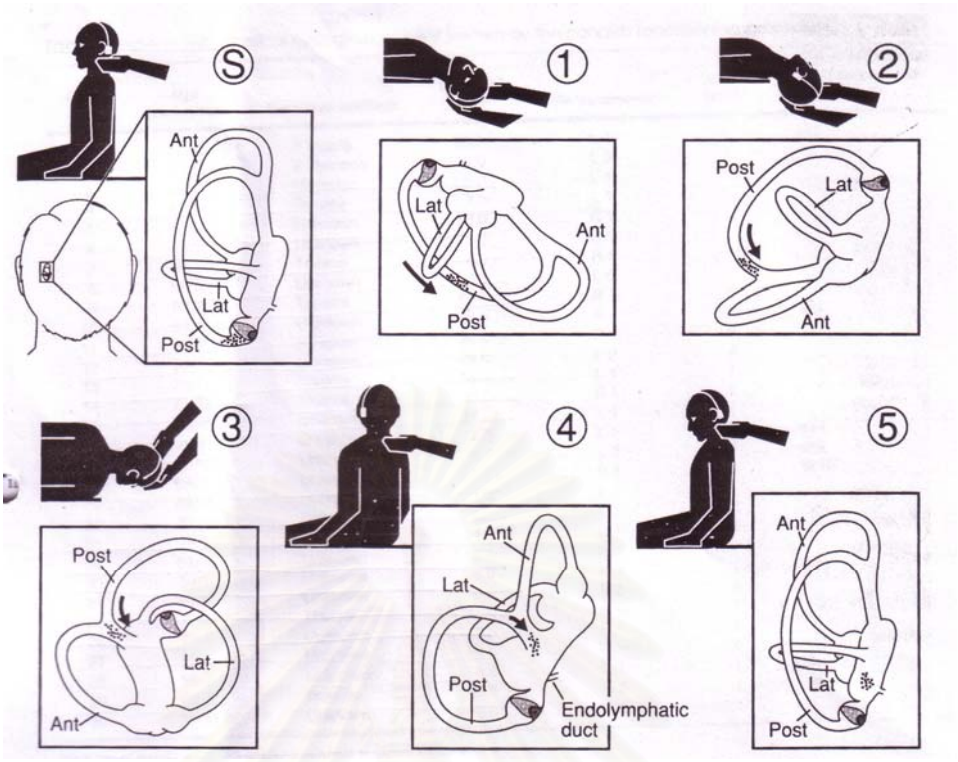


Fig 2.4 Positional for CRP

Semont maneuver

In 1988, Semont et al introduced a single libratory maneuver[37] (fig 2.5). This maneuver require only a single sequence, making them preferable to the multiple repetitions over other repositioning maneuver. Fig 2.5 illustrates the semont maneuver in a patient with typical (posterior canal) left-side BPPV. The clot causes no defection of the cupula in the upright position. When the patient quickly tiled toward the affected left ear with a 45^0 head rotation to the right (moving the left posterior canal to a plane corresponding to the plane of the head tilt), the clot gravitates toward the lower part of the canal, causing the cupula to deflect downward (ampulofugal), and triggering a typical BPPV attack. If the patient is swung toward the opposite right-side with the nose down, the clot will gravitate downward, causing stimulation of the posterior canal of the affected ear. The patient is then slowly moved to the upright position, the clot will gravitate downward through the common crus of the posterior and anterior canals and enter the utricular cavity, where it becomes harmless. Semon et al recommended having the patient maintain the upright position for 48 hours following the therapy.[37]

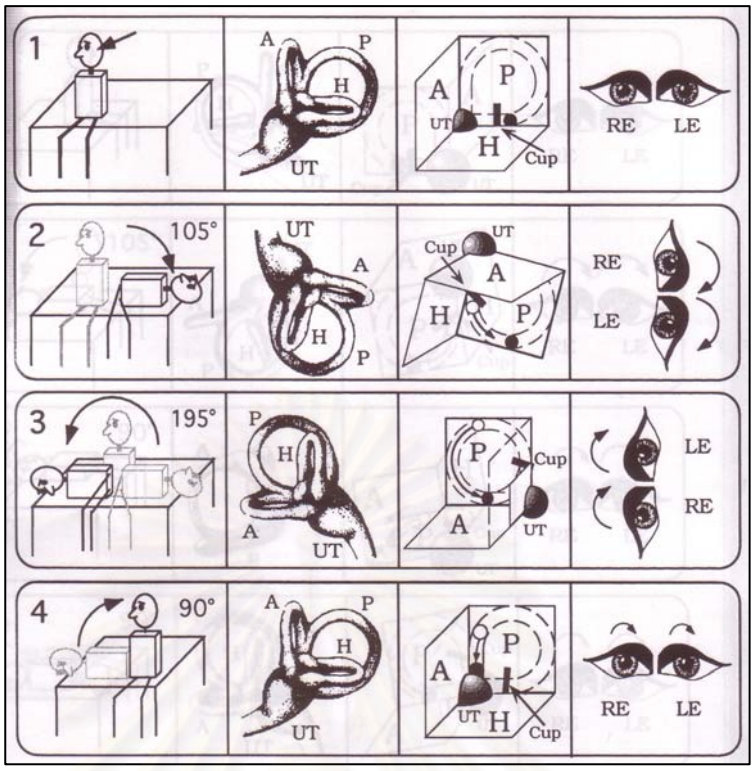


Fig 2.5 Semont maneuver

Brandt-Daroff exercise

This exercise requires the BPPV patient to more repeated into the provoking position several times a day. Remission of vertigo occur in 95 percent, however recovery is gradual and may take several weeks.[13]

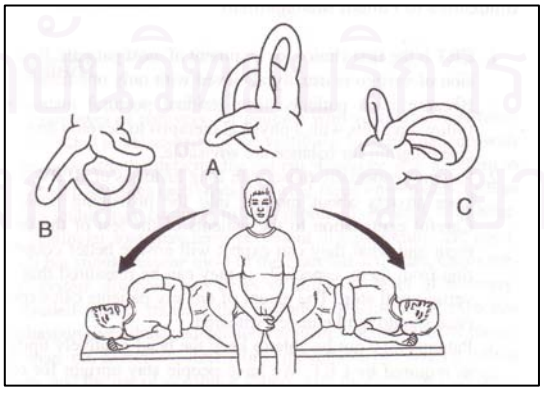


Fig 2.6 Brandt-Daroff exercise

The patient moves quickly into the side-lying position on the affected side and stays in that position until the vertigo stops and an additional 30 second. The patient

then sits up and wait for the vertigo to subside. The patient then repeats the movement to the opposite side, stay there for 30 seconds, and sit up. The entire treatment is repeated several times, usually three times a day until the patient has 2 days with no vertigo.(fig 2.6)

In conclusion, there are three highly effective therapy for BPPV. The Epley maneuver and Semont Liberatory maneuver are easily performed by a physician. The Brandt-Daroff exercises are simple for patient use.

Summary

BPPV is the most common cause of vertigo, particularly in elderly. By age 70, about 30% of all elderly subjects have experienced BPPV at least once. This condition is characterized by brief attacks of rotatory vertigo and concomitant positioning rotatory nystagmus which are elicited by rapid changes in head position relative to gravity.

There are two theory regarding to pathophysiology of BPPV. Cupulolithiasis and Canalithiasis. Cupulolithiasis theory by Schuknecht who discover basophilic particle or densities that were adherent to the cupula and poslulated that the posterior semicircular canal (PSC) was rendered sensitive to gravity by these abnormal dense particles.[3,4] Another theory is Canalithiasis by Epley. This theory consist of free-moving densities in the PSC rather than fixed densities attacked to the cupula. While the head is tilted backward, the particles are rotated up approximately 90 degree along the arm of the posterior semicircular canal. These cause the endolymph to flow away from the cupula and causes the cupula to be deflected and produces nystagmus.[8,9]

The steps for a correct diagnosis of BPPV is based on typical history of positional rotatory vertigo, postural imbalance and also on the presence of a reproducible vertigo and paroxysmal positioning nystagmus by Dix-Hallpike test which should be performed under Frenzel's glasses or during electronystagmography (ENG) recording. A precise diagnosis is very important in view of specific treatment of this type of vertigo by rehabilitation therapy.

The current gold standard of diagnosing BPPV is the Dix-Hallpike test.[1,3] The maneuver is performed by rapidly placing the patient in the lateral supine position with the head hanging below the level of the horizontal plane. This position causes the endolymph to flow away from the ampulla and causes the cupula to be deflected and produce nystagmus. The result is considered positive if the position elicits rotatory nystagmus and vertigo that last for less than 1 minute, are fatigable and are associated with a several seconds latency. When the patient sits up, secondary nystagmus could occur. The special and temporal characteristics of the provoked nystagmus are crucial for diagnosis BPPV.[24,28,29]

Although, the Dix-Hallpike maneuver is mandatory for diagnosis BPPV, there are many limitation to perform this test. Many patients who have cervical spine problem i.e. severe cervical spondylosis, post cervical spine injury or surgery, musculoskeletal limitations, obesity or in patient who have difficulty relaxing enough to allow brisk passive movement of the head backward for fear of eliciting severe vertigo.

Analysis of the survey data from Thai physicians during the Contemporary management strategies for vertigo meeting, in 2004, revealed that most of physicians felt uncomfortable with Dix-Hallpike test in some cases especially those with severe cervical spondylosis or undergone cervical spine injury or operation. They also commented on the limitation of Dix-Hallpike test which need well trained physicians. Ninety percents of physicians look for another more comparable test.[30]

Lateral head trunk tilt or side-lying maneuver which have been introduced by Cohen is another method to examine BPPV patient. The procedure, adapted from Nylen, involvce briskly laying the patient on the side which will stimulate posterior semicircular canal by different biomechanics.

There has been quite only one study regard to alternative test for Dix-Hallpike maneuver. In this study, the study design was prospective, within group in tertiary care diagnostic laboratory center. They planed to do prospective, but actually the records

were reviewed after the test. The data from 61 patients were available only 31 patients. The explanation of this problem was not clear and there could be some bias concerning this matter. Additionally, from 31 patients they calculated only 29 patients that had positive nystagmus. And, only 15 patients had classic response. Furthermore, eye movements were recorded with electrode (ENG) recording which was demonstrated in earlier clinical experiences that contribution of electrode ENG to the diagnosis of BPPV is rather poor, as only half of the cases showed a nystagmus by recording. Finally, the timing effect could not be excluded in methodology because the interval between Side-lying and Dix-Hallpike test maneuver was only 5 minutes. The fatigabitity effect of nystagmus response when doing repeated testing maneuver had already mention in the literature. Inconclusion, the disadvantages of previous paper induced bias selecting the population, too small sample size, poor method of measurement and methodology and also lack of information on negative tests.

It would be helpful if diagnostic test was all backed by sound date comparing its accuracy to an appropriate standard.[31,38] In this case, Side-lying test should be compare with Dix-Hallpike test in disease populations as well as non-disease population. In study of diagnostic accuracy, the outcomes from test under evaluation are compared with outcome form the reference standard in this case the Dix-Hallpike maneuver. The goal of all clinical studies describing the value of diagnostic test should be obtain data for all possibility (include disease, non disease) without all these data, it is not possible to answer important questions concerning the performance of the tests.[38,39,40,41]

CHAPTER III
RESEARCH DESIGN

Research Questions

- Primary research question

What is the diagnostic accuracy of Side lying test for diagnosis Benign Paroxysmal Positional Vertigo as compare to Dix-Hallpike test?

- Secondary research question

- Are there any difference in the adverse events during and after performing these two test?

Research Objectives

- Primary objective

To determine sensitivity, specificity, likelihood ratio and others diagnosis performance of Side-lying test for diagnosis Benign Paroxysmal Positional Vertigo. When compare with Dix-Hallpike test.

- Secondary objective

- To compare the adverse events of Dix-Hallpike and Side-lying test

CONCEPTUAL FRAMEWORK

Benign Paroxysmal Positional Vertigo

BPPV.

Pathophysiology

"Cupulolithiasis"

"Canalolithiasis"

Dix-Hallpike test

Side-lying test

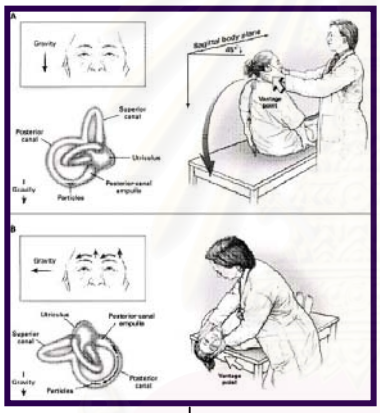


Fig.3.2 Dix-Hallpike procedure

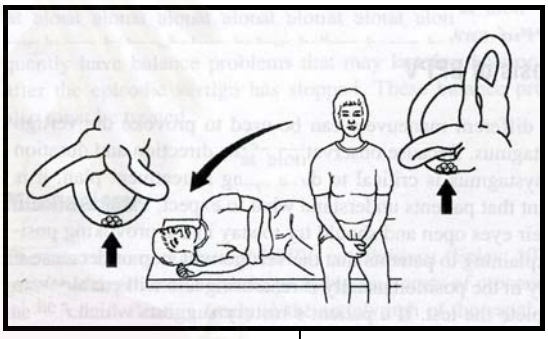


Fig 3.3 Side-lying procedure

Positional nystagmus

Positional nystagmus

Classic positional nystagmus for BPPV

- brief latency (1-5 second)
- limited duration (< 60 second)
- geotropic rotatory nystagmus
- accompany with rotatory vertigo

Diagnosis of BPPV.

Fig 3.1 Conceptual framework

OPERATION DEFINITION

BPPV benign paroxymal positional vertigo is a disease of semicircular canal which occurs as an degeneration process. The typical characteristic of disease is positional vertigo last for seconds.

Dix-Hallpike maneuver (test) is the standard clinical test for BPPV. It is performed by having the patient lie prone with the head turned approximately 45 degrees to the side being tested and slightly hanging over the edge of the examining table. During this, the eyes are examined for nystagmus. The findings of classic rotatory nystagmus with latency and limited duration is concerned pathognomenic. (Figure 2.2)

Side-lying maneuver (test) The patient sits on the bed with the legs over the side and the head is rotated 45 degrees horizontally away from the labyrinth to be tested. The patient then quickly lies down on the side opposite to the direction the head is turned. The patients is asked to report any vertigo and is observed for nystagmus. (figure 2.3)

Positive test result. criteria for positive test result includes

1. nystagmus that occur in brief latency (1-5 second)
2. nystagmus has limited duration (<60 second)
3. the characteristic of nystagmus has to be geotropic rotatory pattern
4. accompany with rotatory vertigo

Nystagmus in defined as involuntary eye movements usually trigger by inner ear stimulation. It usually begins as a slow pursuit eye movement followed by a fast, rapid resetting phase.

Adverse events of the test is the symptom presenting during or after the test which includes.

- Severity of vertigo

  no no serious vertigo

  grade I vertigo with nausea

  grade II vertigo with nausea and vomiting

- Neck pain define as

  no no neck pain or rout pain

  grade I neck pain alone

  grade II neck pain and root pain

Infrared Video Electronystagmography

Infrared Video electronystagmopraphy is a method of recording eye movement which use infrared laser to record the eye movement during many procedure of testing and calculate the result by computerized machine.

RESEARCH DESIGN

Descriptive, cross-sectional study, diagnostic test

CHAPTER IV
RESEARCH METHODOLOGY

POPULATION AND SAMPLE

Target population

Dizzy patients

Study population

Dizzy patients with history of positional vertigo who attended the Dizziness and Hearing clinic, Department of Otolaryngology, King Chulalongkorn Memorial Hospital, and met all the eligible criteria.

Eligible criteria

- Inclusion criteria
  - Dizzy patients age from 18 to 80 years old.
  - Patients who have the dizzy spell onset not more than one month.
  - Agree to participate in the study and sign the informed consent.
- Exclusion criteria
  - Patients with neck problem, in whom the hyperneck extension is contraindicated such as severe neck pain, severe cervical spondylosis, prolapsed intervertebral disc, severe rheumatoid arthritis with cervical instability
  - Dizzy patients who are undertaken antivertigo medication or central nervous system suppressive drug.

Sample size [38,39]

To determine how many subjects should be recruited in order to meet the purpose of the study, the sample size calculations are required. Sample size

calculations require some arbitrary assumptions such as the level of statistical confidence.

Since BPPV has a significant impact on health-related quality of life and diagnosis can lead to improve health-related quality of life a lot by effective repositioning physical therapy. It is expected that sensitivity of the test (side-lying) to identity BPPV is about 90% with 10% allowable error. In a prevalence study confined to one population, the formula for calculating sample size using 95% confidence interval is :[52]

$$n = \frac{Z^2_{\alpha/2} PQ}{d^2}$$

n = number of BPPV patients

p = expected sensitivity of test = 0.90

Q = 1-p

d = accepted error of sensitivity =0.10

Where α = type I error = 0.05

$Z_{0.025} = 1.96$

Thus $$n = \frac{(1.96)^2 (0.90x0.1)}{(0.1)^2}$$

$$n = 34.5744$$

According to our previous study, the data from statistic records of dizzy patients in Dizziness and Hearing clinic[42], Department of Otolarygology, Faculty of Medicine, King Chulalongkorn Memorial Hospital, the prevalence rate of BPPV was about 0.4. Therefore, the required sample size would the be approximately.

$$\text{Sample size} = \frac{n}{\text{Prevalence}}$$

$$= \frac{34.5744}{0.4}$$

$$= 86.43$$

There fore, the required sample size would the be approximately = 86 subjects

PROCEDURE

Dizzy patients who come to the Dizziness and Hearing clinic at Department of Otolaryngology, King Chulalongkorn Memorial hospital, were underwent a complete examination and bed side vestibular test including ear, nose and throat examination, oculomotor test, Romberg's test and tandem gait test.

Patients who met the inclusion criteria were randomly allocated into two groups by simple randomization. Gr.I, Subjects were first given standard Dix-Hallpike maneuver, and then were tested with Side-lying maneuver. In group II, subjects were tested with side-lying maneuver and then Dix-Hallpike maneuvers. In order to eliminate the timing effect the interval between Side-lying and Dix-Hallpike maneuver was 60 minutes.

Dix-Hallpike maneuvers was performed in standard manner. Each subject head was turned with the nose pointing 45° toward the side being tested. The subject was moved briskly into supine-lying, with the neck hyperextended approximately 20° under ENG eye goggle video-recording. The onset and duration of nystagmus were recorded, as well as the severity of vertigo and any adverse events of the maneuver. Then, the patient was asked to sit up and recording of nystagmus and vertigo was done again. (Fig 3.2)

For Side-lying test, the patient sat on the bed with the legs over the side and the head was rotated 45 degrees horizontally away from the labyrinth to be tested. The patient then quickly lied down on the side opposite to the direction the head was turned. The patient was asked to report any vertigo and was observed for nystagmus. The onset and duration of nystagmus as well as the symptom of vertigo were recorded under ENG eye goggle video-recording. Then, the subject was assisted to sit up.(Fig 3.3)

RESEARCH ADMINISTRATION SHEME

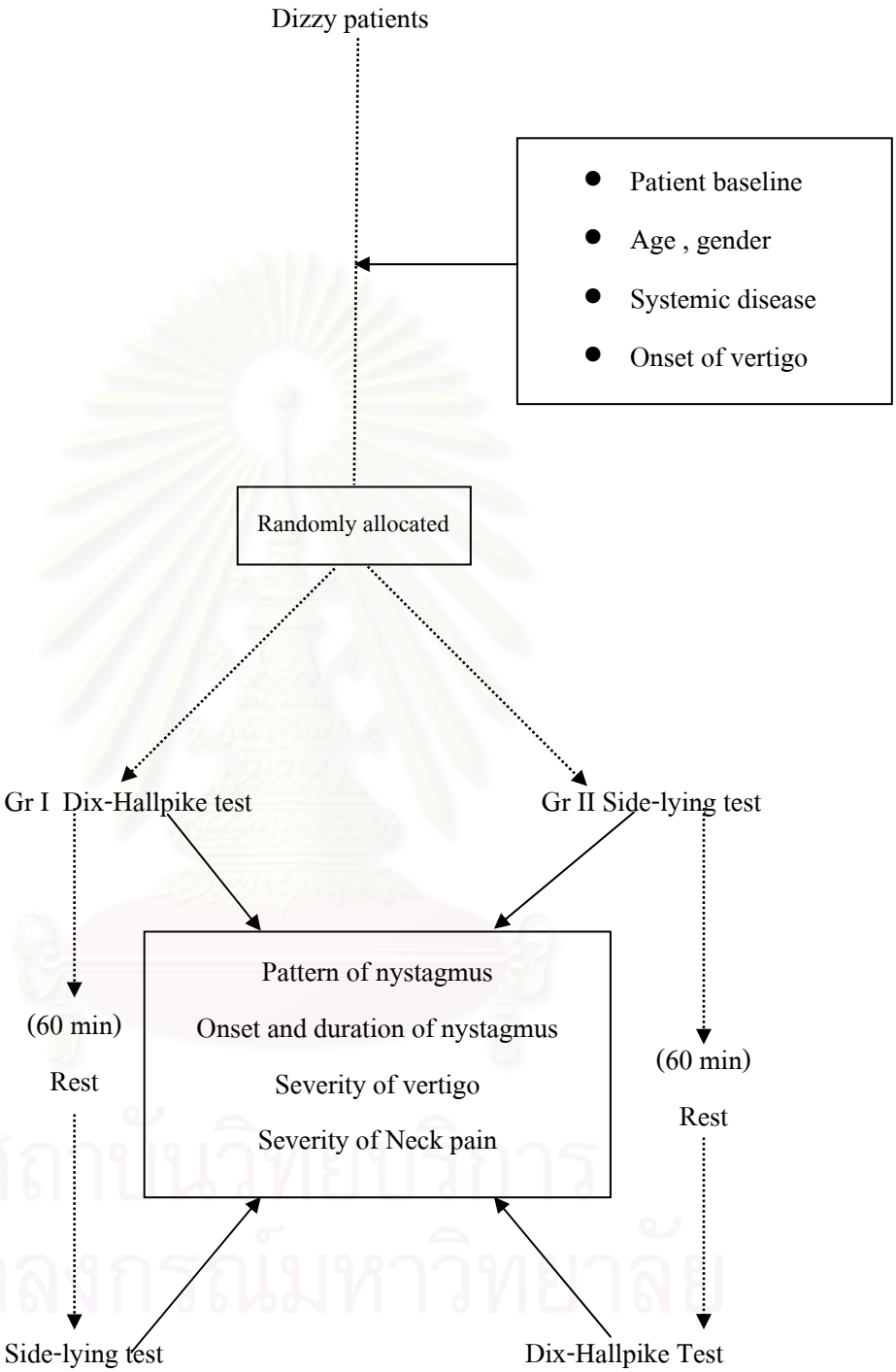


Figure 4.1 research administration sheme

OUTCOME MEASUREMENT

Main outcomes : proportions of positive and negative test result of Dix-Hallpike test and Side-lying test

- Test results of Side-lying test (primary outcome)
- Test results of Dix-Hallpike test (primary outcome)
- Adverse events of Side-lying test (secondary outcome)
- Adverse events of Dix-Hallpike test (secondary outcome)

Primary outcome variable

- The presence or absence of nystagmus (onset and duration of nystagmus are recorded under infrared vedio electronystagmography goggle)
- Positive test result defined as typical (Classic) positional nystagmus response which includes
  1. brief latency (1-5 second)
  2. limited duration (< 60 sec)
  3. nystagmus characteristic of geotropic rotarory nystagmus
  4. accompany with rotatory vertigo

Secondary outcome variable

- Severity vertigo define as the symptom of dizziness sensation during or immediate after the two test

  no no serious vertigo
  grade I vertigo with nausea
  grade II vertigo with nausea and vomiting

- Neck pain is define as

  no no neck pain or root pain
  grade I neck pain alone
  grade II neck pain and root pain

DATA COLLECTION

Case record form was generated for each subject and recorded by research assistant. All the data included:

1. Demographic data , baseline characteristics :
   - Age (yrs)
   - Gender
   - Last vertigo attack
   - History regard to etiology
   - Severity of vertigo

2. Main outcomes :

The outcome variables were recorded as

Intra testing findings

- Positive test result was judged as the presence of geotropic rotatory or horizonto-rotatory nystagmus accompany with vertigo during the test , paroxysmal positional nystagmus had four characteristic
  1. It was usually delayed in onset (1-5 seconds)
  2. It was always transient (duration < 60 seconds)
  3. Nystagmus characteristic of geotropic rotatory nystagmus
  4. It was always accompanied by vertigo (rotatory vertigo)

The presence of nystagmus including slow phase velocity and latency were calculated by electronystagmopraphy computerized machine.

- Adverse events
  1. Intractable vertigo (No, grade I, grade II)
  2. Neck pain , root pain (No, grade I, grade II)

All of the measured variable including administrate variables, baseline variable, test results and adverse events are tabulated in table 4.1

Table 4.1 summary of measured variable

Variable	Scale	Descriptive statistics
Administrative variables		
• Name	Norminal	
• Identification no	Norminal	
• Address	Norminal	
Baseline variables/covariates		
• Age (yr)	Continuous numerical	Mean ± SD
• Sex	Two categorical	N (%)
• Last vertigo attack	Ordinal categorical	N (%)
• Severity of vertigo	Ordinal categorical	N (%)
• History regard to etiology	Dichotomous categorical	N (%)
Outcome variables		
• Result of the test	Dichotomus categorical	
• Severity of vertigo	Ordinal categorical	N (%)
• Neck pain	Ordinal categorical	N (%)

DATA ANALYSIS

General Considerations

The statistical analysis was focused on the accuracy of the new test (Side lying test) as compare to gold standard test (Dix Hallpike maneuver).

The statistical analysis was performed using SPSS for windows, release 11.0.1 (SPSS, Inc).

Plan for statistical data Analysis

Baseline characteristic

Baseline characteristic (age, gender, when was the last vertigo attack, occurance of vertigo) will be performed by descriptive statistics.

Primary objective

- Diagnostic performance[40,41,43,44,45]

Statistical analysis was performed to compare the result (whether test positive or not) of the test between Dix Hallpike test and side lying test and were reported in terms of sensitivity, specificity, positive prediction value, negative predictive value, accuracy and likelihood ratio.

	Gold Standard (Dix-Hallpike test)	
	positive	negative
Side lying test positive	a	b
negative	c	d

Sensitivity is the proportion of positives that are correctly identified by the test.

Sensitivity = a/a+c

Specificity is the proportion of negatives that are correctly identified by the test.

Specificity = d/d+b

95% CI for sensitivity = $(a/a+c) \pm 1.96 \sqrt{\frac{(a/a+c)(c/a+c)}{a+c}}$

95% CI for specificity = $(d/b+d) \pm 1.96 \sqrt{\frac{(d/b+d)(b/b+d)}{b+d}}$

Positive predictive value is the proportion of patients with positive test results who are correctly diagnosed.

positive predictive value = a/a+b

Negative predictive value is the proportion of patients with negative test results who are correctly diagnosed.

negative predictive value = d/d+c

Accuracy = $\frac{a+d}{a+b+c+d}$

Likelihood ratio = $\frac{\text{Prob (positive test / disease)}}{\text{Prob (positive test / no disease)}} = \frac{\text{Sensitivity}}{\text{1-Specificity}}$

$= \frac{a}{(a+c)} \Big/ \frac{b}{(b+d)}$

Secondary objective

- Adverse events of the test

The adverse events of the test including severe vertigo and neck pain will be reported and compared as percentage of cases.

ETHICAL CONSIDERATION

This study was conducted in accordance with the ethical principles and was approved by the ethical committee of Faculty of Medicine, Chulalongkorn University

All the subjects were thoroughly informed prior to recruitment into the study concerning the following items:

- Purposes and method of the study
- Outcome and benefits of the study
- Any possible side effects
- Patients' right to refuse to participate in the study or withdraw from the study at anytime, without affecting their proper medical care.

The informed consent document containing a statement defining that the consent was freely given and had to be sign for every subject. (Appendix II)

CHAPTER V
RESULT OF THE STUDY

Baseline and Demographic data

From nighty-two dizzy patients who met the eligible criteria, only 86 were enrolled into the study during April 2005-Febuary 2006 at Department of Otolaryngology, Faculty of Medicine, Chulalongkorn University. Six patients were dropped because four of them could not wait for long process, other two developed other significant and unrelated health condition a. Among 86 patients in the final sample, 60 were female and 26 were male. The rang of age was 19-79 years old with mean of 54.1 years (table 5.1), Other baseline characteristics included the last vertigo attack, occurrence of vertigo and any history regard to etiology were shown in table 5.1 in form of percentage in each group

Table 5.1 Baseline characteristics and demographic data

Characteristics		
Number of subject		86
Age in years (mean ± SD)		54.1 ± 13.9
		Min = 19 , Max = 79
Sex	male (number (%))	26 (30.2%)
	female (number (%))	60 (69.8%)
	female : male	2.3 : 1
Side	right (number (%))	44 (51.2%)
	left (number (%))	42 (48.8%)
When was the last vertigo attack		
	<3 days	25 (29.1%)
	3-7 days	19 (22.1%)
	1-2 weeks	33 (38.4%)
	>2 weeks	9 (10.5%)
Occurance of vertigo		
	once a day	17 (19.8%)
	many times	58 (67.4%)
	just come only once	11 (12.8%)

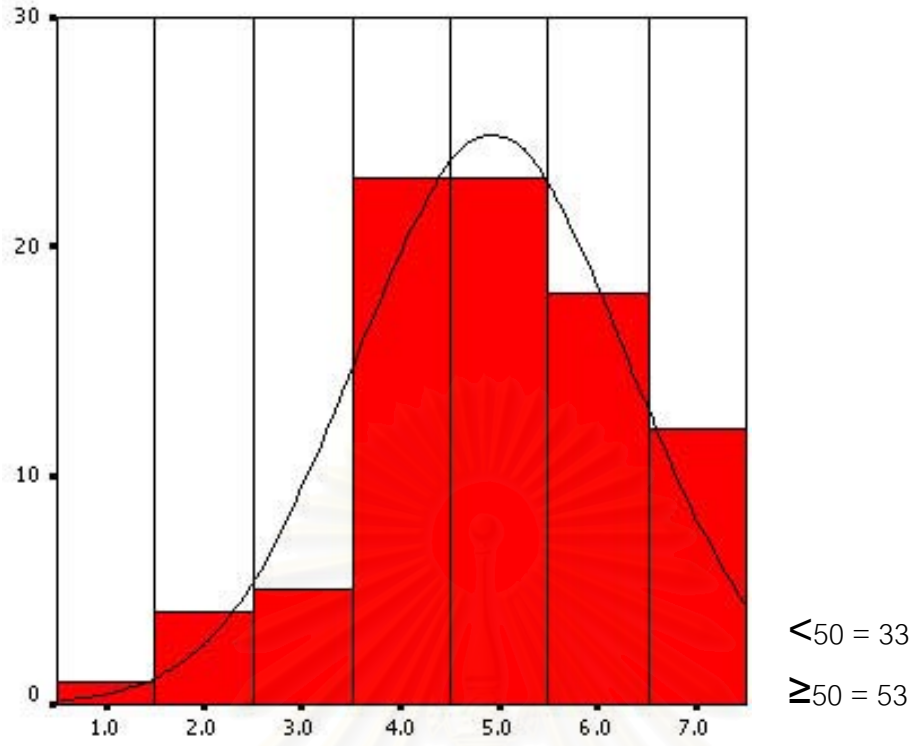
Table 5.1 Baseline characteristics and demographic data (cont.)

Characteristics	
Any history regard to etiology	
no	83 (96.5%)
previous head trauma	3 (3.5%)

Table 5.2 age distribution of patients

	Age group (years)	Number of cases	Percent
1	< 20	1	1.2
2	20-29	4	4.7
3	30-39	5	5.8
4	40-49	23	26.7
5	50-59	23	26.7
6	60-69	18	20.9
4	70-79	12	14.0
	Total	86	100.0

Table 5.2 Shows age distribution in the study group. Predominant age range are 40-49 (26.7%), 50-59 (26.7%) and 60-69 (20.9%). The distribution of age can also be seen by histogram 5.1



Histogram 5.1 age distribution

Outcomes Analysis

Primary objective analysis

Outcomes performance

86 study subjects were tested by using Dix Hallpike test as a gold standard and by side-lying test as a new diagnostic test. Dizzy subjects with present nystagmus were classed as positive cases, and those found absent nystagmus were classed as negative cases.

The number of dizzy patients and BPPV patients diagnosed by Dix Hallpike test were shown in table 5.3

There were 44 cases who had positive test result both Dix-Hallpike and Side-lying test. As well as those 33 negative cases in both tests. The 4 cases of negative Dix Hallpike test but positive Side lying test result includes 2 cases of lateral canal BPPV, one cases of Meniere's disease and one case of vestibular neuritis.

Table 5.3 Result of the tests

Side lying test	Dix Hallpike (gold standard)		Total
	Positive disease	Negative disease	
Positive result	(a) 44	(b) 4	48
Negative result	(c) 5	(a) 33	38
Total	49	37	86

The diagnostic performance

The sensitivity is the proportion of positive that are correctly identified by the test

Sensitivity = a/a+c = 44/(44+5) = 0.898 = 89.8 percent

The specificity is the proportion of negative that are correctly identified by the test

Specificity = a/a+b = 33/ (4+33) = 0.892 = 89.2 percent

Other diagnostic performance are shown in table 5.4

Table 5.4 Diagnostic performance

Diagnostic characteristics	Percentage
Sensitivity a/(a+c)	89.8 (81.3 to 98.6)
Specificity d/ b+d	89.2 (79.2 to 99.2)
Accuracy (a+d)/(a+b+c+d)	89.5
Positive predictive value (PPV) a/(a+b)	91.7
Negative predictive value (NPV) d/(c+d)	86.8
Likelihood ratio $\frac{a}{a+c} \Big/ \frac{b}{b+d}$ $Sensitivity \Big/ 1-spec$	8.3

The sensitivity of Side-lying test using Dix-Hallpike test as the gold standard was relatively high (89.8%) as well as the specificity (89.2%). The probability that the subjects with a positive test result would have benigh paroxysmal positional vertigo (positive predictive value) was 91.7% and the probability that an individual with a negative test result would not have benign paroxysmal positional vertigo (negative predictive value) was 86.8%. The chance of test positive if the subject has disease (likelihood rotio) is 8 times to the chance of a positive result of the subject does not

have disease. A high likelihood ratio for a positive result reveals that this test provides beneficial information.

The Prevalence of BPPV

Prevalence = (44+5)/(44+4+5+33) = 0.57 = 57 percent

False positive rate = 4/(4+33) = 0.108

False negative rate = 5/(44+5) = 0.102

By using Dix-Hallpike test as the gold standard, the prevalence of beign paroxysmal positional vertigo in this study was 57 percent, False positive rate is 10.8 percent and false negative rate is 10.2 percent.

Sub-group analysis

When we divided the patients into two groups according to their age whether they are younger than 50 years old (<50) or equal and older than 50 year old (50-80 years old). The diagnostic performance was analyzed in 33 dizzy patients in gr I. and 53 patients in group II.

The test result of gr I and gr II were shown in table 5.5

Table 5.5 outcome findings in gr I (age < 50 years old)

Side lying test	Dix Hallpike (gold standard)		Total
	Positive disease	Negative disease	
Positive result	11	0	11
Negative result	3	19	22
Total	14	19	33

Table 5.6 outcome findings in gr II (age ≥50 years old)

Side lying test	Dix Hallpike (gold standard)		Total
	Positive disease	Negative disease	
Positive result	33	4	37
Negative result	2	14	16
Total	35	18	53

Table 5.7 Diagnostic performances of two groups.

Characteristic of test	Age < 50 (percent)	Age ⩾ 50 (percent)
Sensitivity	78.6	94.3
Specificity	100.0	77.8
False positive rate	0.0	22.2
False negative rate	21.4	5.7
Accuracy	90.9	88.7
Positive predictive value (PPV)	100.0	89.2
Negative predictive value (NPV)	86.4	87.5
Prevalence	42.4	66.0

The diagnositic performance of patients in group I (age <50) demonstrated that the specificity of the side-lying test is very high (100 percent) and the faise positive rate was zero. Also the positive predictive value was 100 percent.

In group II (age > 50), the sensitivity of the test is higher than gr I, but the specificity is lower. There is still high false positive rate (22.2 percent) in this group.

The prevalence rate of disease (BPPV) was 42.4 percent in group I and slightly higher in group II (66 percent).

Secondary objective analysis

The secondary objective is to compare adverse events of Dix-Hallpike test and Side-lying test.

Table 5.8 shows the adverse event as define by severity of vertigo during the test and neck pain and root pain.

Table 5.8 Summary of adverse events

Adverse events	Dix-Hallpike test	Side-lying test
Severity of vertigo		
• No (number (%))	74 (86.1%)	76 (88.4%)
• grade I	12 (13.9%)	10 (11.6%)
• grade II	0 (0%)	0 (0%)
neck pain		
• no (number (%))	85 (98.8%)	86 (100%)
• grade I	1 (1.2%)	0 (0%)
• grade II	0 (0%)	0 (0%)

Severity of vertigo during the test is slightly higher during Dix-Hallpike test (13.9%) as compare to side-lying test (11.6%).

Another side effect of the test is neck pain. During the Dix-Hallpike test, one patient complaint of neck pain (1.2%). There is no adverse event regarding to neck pain during the Side-lying test.

CHAPTER VI
DISCUSSION

Baseline and Demographic data

Similar to other studies[4,6,17,19] in the literature, the average age of BPPV in this study was 54.1 yrs and more BPPV patients in advance age group.

The characteristic epidemiologic features of BPPV as shown in table 5.1. The age distribution is range from 19 year old to 79 years old. The predominant age distribution was 40 to 50 and 50 to 60 and the trend was more parentage of BPPV in older age than in younger age.

According to gender distribution, The female preponderance of BPPV was previously observed by Katsarkas and Kirkham [15] of their 255 cases, 175 were females and only 80 were males. In this study, female outnumbered male 2.3 to 1. Possibly, hormonal facter are important in the cause of idiopathic BPPV. Assuming that Schuknecht's cupulolithiasis theory is correct, metabolic changes in the calcium carbonate crystals of the otolithic membrane in females could be important in the pathophysiology of BPPV. There was no side predominance.

Of our 86 patients, three (3.5 percent) reported having head trauma before the onset of symptoms and the diagnosis of BPPV. Similarly, 17 percent of the patients described by Katsarkas and Kirham [15] and 18 percent of those in baloh and associated study [17] had prior head trauma. From this study design, however did not allow as to address the relative risk of BPPV associated with prior head trauma.

Discussion of outcome analysis [48,49,50,51]

The purpose of this study is to determine the diagnostic accuracy of side-lying test for diagnosis BPPV using the Dix-Hallpike as a gold standard.

To determine how good of diagnostic test depends on the ability of the test to differentiating disease from non-diseased subjects. The fundamental way to consider is that where patients can be classified into two groups according to the result of Dix-Hallpike test, as the positive or negative of disease. Table 5.3 , which shows the relation between test of interest here is how good is the side-lying test at diagnosis of benign paroxyscl positional vertigo.

Firstly , to compute the proposition of patients with presence and absence disease diagnosed by Dix-Hallpike maneuver. There are 49 positives and 37 negative. The proportions of there two groups that have correct diagnosis on side-lying test are 44/49 = 0.898 (sensitivity) and 33/37 = 0.892 (specificity) respectively. The accuray of side-lying test is 89.5 percent. Therefore, we can say that from this study, one would expect nearly 90% of patients with benign paroxysmal positional vertigo to have positive side-lying test, as well as nearly 90% of those with no disease would have negative side-lying test. There rang of 95% CI for the sensitivity (81.3-98.6) and specificity (79.2 to 99.2) are relatively wide. These could be due to the sample population. If the number of sample is increased, one can expact to see the 95% CI of sensitivity and specificity more narrow.

However, the main point of a diagnostic tool is to use it to help making a diagnosis, so we need to know what is the chance of the test giving the correct result, whether it is positive or negative. The sensitive and specialty do not give this information. So one should approach the data from the direction of the test result.[46,47,48]

Of the 48 subjects with positive side-lying test, 44 had benign paroxysmal positional vertigo. Therefore the positive predictive value or the proportion of subjects with positive test result who are correctly diagnosed is 44/48 = 0.917 Likewise, among the 38 subjects with negative side-lying test the proposition of correct diagnose was 33/38 = 0.868.

From this study, side-lying test give a rather high positive predictive value and negative predictive value. This mean that it is useful in clinical practice. Nevertheless, the predictive value are depend on the prevalence. The prevalence of benign paroxysmal positional vertigo in this study was relatively high (57 percent). Thus, making the predictive value are very high value. In other clinical setting where the prevalence of BPPV is not as high as this sitting, the predictive values might be deferent.

At last, the likelihood ratio which defined as the likelihood of that test result in the diseased group divided by likelihood of the same test result in the non-diseased group. Likelihood expresses how many times more (or less) likely a test result is to be found in disease, compared with non diseased population.[48]

The positive likelihood ratio in this study is 8.3 which verified that an individual with BPPV is 8.3 times more likely to have test positive than in normal population. This high likelihood ratio for a positive result has verified that side-lying test provides useful information.

Subgroup analysis

Benign proxysenal positional vertigo are the most common vestibular disorder. In one cohort study, the mean age at onset was 54 years, with a range of 11 to 84 years[4,6]. Many other study found that BPPV associated with old age or caused by degeneration. In this study, we found the mean age was approximatly 54.1 years like other study and the age range was between 19-79 years.

Considering the age effect, we had divided dizzy subjects into two group according to their age. Group I age range from 19 to 50 years old, and group II age is equal or above 50 years. We decided the age cut off point is 50 years old because when we consider that BPPV is more affected middle to old age group and it is more likely to effect female. So it could be related to hormonal deficiency in menopausal group.

The diagnostic performances in group I were high specificity, zero false positive rate and very high positive predicative value. These means that if one whose age below 50 years had a positive side lying test, one probable had a high chance to has BPPV. However if this test is used as the screening test for diagnosis BPPV in dizzy population. It is suitable for people age above 50 (higher sensitivity)

The prevalence of disease was different in two groups. The higher incidence was found in those whose age is equal or above 50 years similar to other study that BPPV is usually occurred in middle to old age populaition. However, the subgroup analysis was not planned before study, all the result and interpretation of the analysis should be considered carefully.

Secondary objective analysis

When compare the adverse events between Dix-Hallpike test and side-lying test, there is slightly difference regarded to the severity of vertigo. During Dix-Hallpike maneuver, some subjective experienced feeling of severe vertigo (13.9%), slightly lighter than during the side-lying test (11.6%)

As the neck pain during the test was concerned, there is only one case reported during Dix-Hallpike maneuver (1.2%)

The adverse events during the two tests is not statistically significant. This could be due to the small number of the subjects or because of the exclusion criteria that we excluded the dizzy subjects who had cervical spondylosis or neck problem.

Limitation

This study may have limitation on generalizability. Firstly, because the study was performed at the Dizzy clinic, department of Otolaryngology, Faculty of Medicine, Chulalongkorn University which is the tertiary care center. The prevalance rate of BPPV is relatively high compare to general outpatient clinic. Secondly, to study diagnostic

performance of a test the tester or who interpretrate the result should be blind. In our study, even the result is computerized by electronystagmography machine, still needed interpretor decide whether the test is positive or negative. Moreovers, we could not blind the examiner who performed the test.

All of these have some power on the result of the diagnositic performance of the test.

CONCLUSION

The sensitivity, specificity, accuracy as well as other diagnostic performance of Side-lying test is relatively high for diagnosis benign paroxysmal positional vertigo use Dix Hallpike as a gold standard.

The information obtained from this study yields Side-lying can be alternative choice for diagnosis BPPV if Dix Hallpike is contraindicate. The adverse events during these two test procedure were not much different including the neck pain. However , all the subjects in this study had no history of neck problem (ie. cervical spondylosis, neck injury or sergery, limitation of neck movement).

Further study which aims to demonstrate the usefulness of Side-lying test in those who have neck problem is recommended to evaluate whether Side-lying test is an perfect alternative to Dix Hallpike test in that situation or not.

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APPENDICES

APPENDIX A

PATIENT INFORMATION AND CONSENT FORM
ข้อมูลสำหรับผู้ป่วยและใบยินยอมอนุญาต

โครงการการศึกษาความแม่นยำของการทดสอบ Side-lying ในการวินิจฉัยโรคเวียนศีรษะ

Benign Paroxysmal Positional Vertigo (BPPV)

โรค Benign paroxysmal positional vertigo (BPPV) หรือโรคหินปูนชั้นในเคลื่อน เป็นโรคที่เป็นสาเหตุของอาการเวียนศีรษะที่พบได้บ่อยที่สุด โรคนี้ผู้ป่วย มักมีอาการเวียนศีรษะ เมื่อมีการเคลื่อนไหวศีรษะ เช่น ล้มตัวลงนอน ลุกจากที่นอน ก้ม เงย อาการเวียนศีรษะจะมีการเวียนศีรษะแบบหมุน ตามด้วยอาการคลื่นไส้ อาเจียน อาการเวียนศีรษะมักจะเป็นไม่นาน แต่จะถูกกระตุ้นให้เกิดอาการได้ เมื่อมีการเคลื่อนไหวศีรษะในท่าเดิม

โรคเวียนศีรษะชนิดหินปูนในหูชั้นในเคลื่อน นี้ ในทางพยาธิวิทยาจะพบความผิดปกติในอวัยวะการทรงตัวของหูชั้นใน โดยพบตะกอนหินปูนที่เป็นแคลเซียมคาร์บอเนต (Calcium Carbonate) อยู่ผิดที่ หรือหลุดออกจากที่เดิม ซึ่งจะทำให้เกิดการกระตุ้นอวัยวะการทรงตัวในหูชั้นใน ก่อให้เกิดอาการเวียนศีรษะ

ในการรักษาโรคนี้ ปัจจุบันทำการรักษาโดยวิธีกายภาพเพื่อเคลื่อนตะกอนหินปูนให้เข้าสู่ภาวะปกติ (Repositioning maneuver) เป็นการรักษาที่ได้ผลดีมาก ซึ่งการกระทำการรักษาดังกล่าวได้ ขึ้นอยู่กับการทดสอบได้อย่างถูกต้องก่อน

สำหรับการวินิจฉัยโรคนี้ ปัจจุบันใช้วิธีทดสอบ Dix-Hallpike test โดยให้ผู้ป่วยล้มตัวลงนอนหงายอย่างรวดเร็ว และห้อยศีรษะในท่าตะแคงซ้ายหรือขวา โดยทำทีละข้าง แพทย์จะตรวจดูการกระตุกของลูกตา ซึ่งถ้าพบว่าเป็นโรคนี้ จะได้การทดสอบผลบวก คือจะพบการกระตุกของลูกตาแบบหมุนร่วมกับอาการเวียนศีรษะ

การทดสอบ Dix-Hallpike test มีข้อจำกัดหลายอย่าง อาทิเช่น ไม่สามารถทำได้ในรายผู้ป่วยที่มีปัญหาเรื่องกระดูกคอ เช่น เป็นโรคกระดูกคอเสื่อม (Cervical spondylosis) กระดูกคอติดแข็ง (Cervical stiffness) หรือเพิ่งผ่าตัดกระดูกคอมา

การทดสอบ Side lying test เป็นการทดสอบใหม่ จุดประสงค์เพื่อมาทดแทนการทดสอบ Dix-Hallpike test เพื่อสามารถใช้ได้ในผู้ป่วยที่มีปัญหาคอดังกล่าวมาแล้ว แต่ในปัจจุบันยังไม่มีการวัดมาตรฐานของการทดสอบนี้ชัดเจน

โครงการการศึกษานี้ จุดประสงค์เพื่อนำการทดสอบนี้มาทดแทน Dix Hallpike test ถ้าพบว่ามาตรฐานใกล้เคียงกัน

ผู้ร่วมการศึกษาจะได้รับการทดสอบทั้ง Dix-Hallpike test (แบบดั้งเดิม) และ Side-lying test ภายใต้การดูแลของแพทย์ ณ คลินิกเวียนศีรษะและการได้ยิน ใน ภปร.10 แผนก หู คอ จมูก โดยจะบันทึกผลการทดสอบ เพื่อนำข้อมูลไปใช้ ภายในด้านการศึกษาเท่านั้น

สำหรับอาการไม่พึงประสงค์ ที่อาจเกิดได้ขณะได้รับการศึกษานี้ ได้แก่

1. อาการเวียนศีรษะ
2. อาการปวดบริเวณคอ จากการทดสอบแบบดั้งเดิม คือ Dix Hallpike test

ประโยชน์ของการศึกษา

1. อาจทำให้พบ การทดสอบใหม่ สำหรับวินิจฉัยโรคเวียนศีรษะ ชนิด BPPV. ยังใช้ได้สะดวกกว่า , ง่ายกว่า
2. สามารถนำการทดสอบนี้ไปใช้ในผู้ป่วยที่มีปัญหาเรื่องคอ

APPENDIX B

หนังสือยินยอมเข้าร่วมการศึกษาวิจัย (Consent form)

ข้าพเจ้า.....ได้รับทราบจากแพทย์ผู้รักษา ซึ่งได้ลงนามด้านท้ายของหนังสือนี้ถึงวัตถุประสงค์ลักษณะ และแนวทางการศึกษาโครงการการศึกษาความแม่นยำของการทดสอบ Side-lying ในการวินิจฉัยโรค benign paroxysmal positional vertigo (BPPV) โดยวิธีทดสอบ Side lying test เปรียบเทียบกับวิธีทดสอบมาตรฐาน Dix Hallpike test รวมทั้งทราบถึงผลดีที่จะได้รับ ผลข้างเคียง และความเสี่ยงที่อาจเกิดขึ้น ข้าพเจ้าได้ซักถาม ทำความเข้าใจเกี่ยวกับการศึกษาดังกล่าว เป็นที่เรียบร้อยแล้ว

ข้าพเจ้ายินดีเข้าร่วมการศึกษาวิจัยนี้โดยสมัครใจ และอาจถอนตัวจากการเข้าร่วมการศึกษานี้เมื่อใดก็ได้ โดยไม่จำเป็นต้องแจ้งเหตุผล และยอมรับสิ่งไม่พึงประสงค์ที่อาจเกิดขึ้น และจะปฏิบัติตัวตามคำแนะนำของแพทย์ทุกประการ ข้าพเจ้ารับทราบว่า หากข้าพเจ้าถอนตัวจากการเข้าร่วมการศึกษา จะไม่มีผลกระทบใดๆ ต่อมาตรฐานการรักษาที่ข้าพเจ้าพึงจะได้รับจากแพทย์

ผู้วิจัยรับรองว่าจะเก็บข้อมูลเฉพาะเกี่ยวกับตัวข้าพเจ้าเป็นความลับ และจะเปิดเผยได้เฉพาะในรูปที่เป็นสรุปผลการวิจัย การเปิดเผยข้อมูลเกี่ยวกับตัวข้าพเจ้าต่อหน่วยงานต่างๆ ที่เกี่ยวข้องกระทำได้เฉพาะกรณีจำเป็น ด้วยเหตุผลทางวิชาการเท่านั้น

ข้าพเจ้ายินดีให้ข้อมูลของข้าพเจ้าแก่คณะแพทย์ผู้รักษา เพื่อประโยชน์ในการศึกษาวิจัยครั้งนี้

ข้าพเจ้าได้อ่านข้อความข้างต้นแล้วและมีความเข้าใจดีทุกประการ และได้ลงนามในใบยินยอมนี้ด้วยความเต็มใจ

วันที่.....เดือน.....พ.ศ. .....

ลงชื่อ.....ผู้เข้าร่วมการวิจัย

(.....)

ลงชื่อ.....แพทย์ผู้ดำเนินการวิจัย

(แพทย์หญิงเสาวรส อัศววิเชียรจินดา)

ลงชื่อ.....พยาน

(.....)

ลงชื่อ.....พยาน

(.....)

APPENDIX C

CASE RECORD FORM

Pat initials…….. Pat No.

___/___/___

Diagnostic accuracy of Side-lying test for diagnosis

Benign Paroxysmal Positional Vertigo (BPPV)

CASE RECORD FORM

Principal investigator

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Bangkok, Thailand

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Fax : +662 2527787

Pat initials…….. Pat No. ___/___/___

Assessment data ____/____/____

dd mm yy

Eligibility criteria

Inclusion criteria	**No**	**Yes**
■ Written informed consent	[ ]	[ ]
■ Age 18-80 years	[ ]	[ ]
■ Last dizzy spell onset not more than one month	[ ]	[ ]
■ Agree to participate in the study and sign the informed consent.	[ ]	[ ]
Exclusion criteria		
■ Neck problem : severe cervical spondylosis, Prolapsed intervertebral disc, sevsere rheumatoid arthritis with cervical instability	[ ]	[ ]
■ Undertaken antivertigo medication	[ ]	[ ]
■ Undertaken CNS suppressive drug	[ ]	[ ]
Conclusion		
■ Patient fulfils all inclusion criteria and none of the exclusion criteria	[ ]	[ ]

Pat initials…….. Pat No. ___/___/___

Assessment data ____/____/____

dd mm yy

Patient description

Date of birth ___/___/___

dd mm yy

Day ,Month and year at last vertigo attack ___/___/___

dd mm yy

Sex (M,F) ___/___

Age _____Yrs.

When was the last vertigo attack

[ ] < 3 days

[ ] 3-7 days

[ ] 1-2 weeks

[ ] > 2 weeks

Occurance of vertigo

[ ] once a day

[ ] many times a day depend on head position

[ ] just come only once

Any history regard to etiology

[ ] previous head trauma, when_____

[ ] previous ear surgery, when_____

[ ] previous ear disease, what_____when_____

Physical examination

Dix Hallpike's maneuver

Primary outcome

1) When Lt ear down : nystagmus [ ] present [ ] absent

character of nystagmus [ ] horizontal

[ ] rotatory

[ ] horizontal rotatory

[ ] other_____

if nystagmus present [ ] beating to gravity

[ ] beating opposite to gravity

onset_____(sec) latency_____(sec)

slow phase eye velocity_____

Conclusion of test result [ ] positive [ ] negative

2) When Rt eat down : nystagmus [ ] present [ ] absent

character of nystagmus [ ] horizontal

[ ] rotatory

[ ] horizontal rotatory

[ ] other_____

if nystagmus present [ ] beating to gravity

[ ] beating opposite to gravity

onset_____(sec) latency_____(sec)

slow phase eye velocity_____

Conclusion of test result [ ] positive [ ] negative

Secondary outcome

- Severity of vertigo

  [ ] No (no serious vertigo)

  [ ] grade I (vertigo with nausea)

  [ ] grade II (vertigo with vomiting)

- Neck pain

  [ ] No (no neck pain and root pain)

  [ ] grade I (neck pain alone)

  [ ] grade II (neck pain and root pain)

Side-lying test

Primary outcome

1) When Lt ear down : nystagmus [ ] present [ ] absent

character of nystagmus [ ] horizontal

[ ] rotatory

[ ] horizontal rotatory

[ ] other_____

if nystagmus present [ ] beating to gravity

[ ] beating opposite to gravity

onset_____(sec) latency_____(sec)

slow phase eye velocity_____

Conclusion of test result [ ] positive [ ] negative

2) When Rt eat down : nystagmus [ ] present [ ] absent

character of nystagmus [ ] horizontal

[ ] rotatory

[ ] horizontal rotatory

[ ] other_____

if nystagmus present [ ] beating to gravity

[ ] beating opposite to gravity

onset_____(sec) latency_____(sec)

slow phase eye velocity_____

Conclusion of test result [ ] positive [ ] negative

Secondary outcome

- Severity of vertigo

  [ ] No (no serious vertigo)

  [ ] grade I (vertigo with nausea)

  [ ] grade II (vertigo with vomiting)

- Neck pain

  [ ] No (no neck pain and root pain)

  [ ] grade I (neck pain alone)

  [ ] grade II (neck pain and root pain)

APPENDIX D

The START statement checklist

Checklist

Table 1. START checklist of items to the repoeting of studies on diagnostic accuracy.

Test version , November 2001 . For evaluation purposes only.

Section and Topic	Item #	Describe	Reported On page #
TITLE/ABSTRACT/ KEYWORDS	1	The article as a study on diagnostic accuracy (recommend MeSH heading 'sensitivity and specificity')	
INTRODUCTION	2	The research question(s) such as estimating diagnostic accuracy or comparing accuracy between tests or across participant groups	
METHODS			
Participants	3	The study population: the inclusion and exclusion criteria, setting(s) and location(s) where the data were collected	
	4	Participant recruitment: was this base on presenting symptoms, result from previous tests, or the fact that the participants had received the index test(s) or the reference standard?	
	5	Participant sampling: was this a consecutive series of patients defined by selection criteria in (3) and (4)? If not specify how patients were further selected.	

Section and Topic	Item #	Describe	Reported On page #
	6	Data collection: were the participants identified and data collected before the index test(s) and reference standards were performed (prospective study) or after (retrospective study)?	
Reference standard	7	The reference standard and its rationale	
Test methods	8	Technical specification of material and methods involved including hoe and when measurements were taken, and/or cite reference for index test(s) and reference standard	
	9	Definition and rationale for the inits, cutoffs and/or catrgories of the results of the index test(s) and the reference standard	
	10	The number, training and expertise of the persons (a) executing and (b) reading the index test(s) and the reference standard	
	11	Whether or not the reader(s) of the index test(s) and reference standard were blind (masked) to the results of the other test(s) and describe any information available to them	
Statistical methods	12	Methods for calculating measures of diagnostic accuracy or making comparisons, and the statistical methods used to quantify uncertainty (e.g 95% confidence intervals)	
	13	Methods for calculating test reproducibility, if done	
RESULTS			

Section and Topic	Item #	Describe	Reported On page #
Participants	14	When study was done, including beginning and ending dates of recruitment	
	15	Clinical and demographic characteristics (e.g. age, sex, spectrum of presenting symptom(s), comorbidity, current treatment(s), recruitment center)	
	16	How many participants satisfying the criteria for inclusion did or did not undergo the index test and/or the reference standard; describe why participants failed to receive either test (a flow diagram is strongly recommended)	
Reference standard	17	Time interval and any treatment administered between index and reference standard	
	18	Distribution of severity of disease (define criteria) in those with the target condition; describe other diagnoses in participants without the target condition	
Test results	19	Across tabulation of the results of the index test(s) by the result of the reference standard; for continuous results, the distribution of the test results by the results of the reference standard	
	20	Indeterminate results, missing responses and outliers of index test(s) stratified by reference standard result and how they were handled	
	21	Adverse events of index test(s) and reference standard	

Section and Topic	Item #	Describe	Reported On page #
Estimation	22	Estimates of diagnostic accuracy and measures of statistical uncertainty (e.g. 95% confidence intervals)	
	23	Estimates of variability of diagnostic accuracy between subgroups of participants, readers or centers, if done	
	24	Measures of test reproducibility, if done	
DISCUSSION	25	The clinical applicability of the study findings	

VITAE

Dr. Saowaros Asawavichianginda was born on November 19, 1960 in Bangkok. She was graduated with M.D degree from Faculty of Medicine Siriraj Hospital, Mahidol University, Thailand. In 1991, she received Thai Board in Otolaryngology, Faculty of Medicine, Chulalongkorn University. From 1993 to 1994 she studied abroad at the Toronto General Hospital and obtained a certificate of fellowship in Neuro-Otology from University of Toronto, Canada.

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