J Am Acad Audiol 23:616–622 (2012)

Performance of Fukuda Stepping Test as a Function of the Severity of Caloric Weakness in Chronic Dizzy Patients

DOI: 10.3766/jaaa.23.8.6

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Abstract

Background: The purpose of the Fukuda Stepping Test (FST) is to measure asymmetrical vestibulospinal reflex tone resulting from labyrinthine dysfunction. The FST is a low cost evaluation for dizzy patients; however, when compared with gold standard caloric irrigation unilateral weakness (UW) value ≥25%, the FST has not been shown to be a sensitive tool for identifying unilateral vestibular hypofunction.

Purpose: The purpose of this technical report is to further evaluate the clinical utility of FST with and without headshake as a function of increased caloric asymmetry for individuals with unilateral peripheral vestibular pathology.

Research Design: Retrospective review of FST results with and without head shaking component as compared to gold standard, caloric irrigation UW outcome values at four severity levels: 0–24% UW (normal caloric value); 25–50% UW (mild caloric UW); 51–75% UW (moderate caloric UW); 76–100% UW (severe caloric UW).

Study Sample: 736 chronic (≥8 wk symptom complaints) dizzy patients.

Results: Standard FST and FST following a head shake task are insensitive to detecting mild to moderate peripheral vestibular paresis. Increased test performance was observed for patients with severe canal paresis (>76% UW); however, continued inconsistencies were found in turn direction toward the severe unilateral vestibular dysfunction.

Conclusions: Overall, the FST provides little benefit to clinicians when used in the vestibular bedside examination.

Key Words: Caloric irrigations, Fukuda Stepping Test, head shake, unilateral weakness

Abbreviations: AUC = area under the curve; FST = Fukuda Stepping Test; ROC = receiver operating characteristic; UW = unilateral weakness; VOR = vestibulo-ocular reflex; VSR = vestibulospinal reflex

The vestibular system senses angular and linear acceleration during activities of daily living and generates appropriate eye, head, and body movements to stabilize our vision, posture, and gait. The vestibulo-ocular reflex (VOR) maintains gaze stability by signaling agonist-antagonist extraocular muscles to reposition the eyes to minimize retinal slip and preserve the clarity of the visual scene during head movements (Baloh and Honrubia, 2001). Activation of spinal cord motor neurons through the lateral and medial vestibulospinal tracts (vestibulospinal reflex [VSR]) activates extensor and flexor skeletal muscles to provide postural control during standing and helps stabilize the body while performing dynamic movements such as walking or running (Fetter and Dichgans, 1996; Gleason, 2008).

The vestibular end organs influence the VOR and VSR reflex pathways. The VOR and VSR function through a

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push-pull system, signaling appropriate muscle activation and inhibition to appropriately stabilize the eyes on a target and limbs to prevent a fall. For example, if an individual is rotated to the right at a constant speed, and suddenly brought to an immediate stop, endolymph within the horizontal semicircular canals will flow toward the right, causing the cupula within the left ampulla to shear the hair cilia toward the utricle (utriculopetal response: excitation) and the cupula within the right ampulla to shear the hair cilia away from the utricle (utriculofugal response: inhibition). The patient senses that they are now being rotated to the left, and nystagmus is observed with the beat of the nystagmus (fast component) to the left, and the slow component of eye deviation (VOR response) in the direction of the endolymph flow, to the right (Baloh and Honrubia, 2001). If that same individual were standing unrestrained after the sudden deceleration, the person would tend to fall in the direction of the slow component of nystagmus (Baloh and Honrubia, 2001). However, activation of the VSR signals an extensor muscle response for the extremities on the side of the fall and reduced extensor tone on the contralateral side to right the individual and prevent a fall (Pompeiano and Allum, 1988).

A unilateral peripheral vestibular dysfunction can produce a similar response, given asymmetrical neural firing rate. The person may show signs of impaired visual acuity (reduced VOR response) or impaired postural control and gait (reduced VSR response), leading to symptom complaints of dizziness and unsteadiness. Sensitive, reliable VOR assessment measures (e.g., caloric irrigations) have served as the "gold standard" for identifying peripheral vestibular dysfunction (Fife et al, 2000) partly due to the ease in evaluating this system in isolation of other sensory systems; however, VSR measurements also serve as a method for evaluating labyrinthine dysfunction, via observation of reduced VSR tone (Barany, 1910; Unterberger, 1938; Hirsch, 1940; Fukuda, 1959; Baloh and Honrubia, 2001). The Romberg Test, Past Pointing Test, and Fukuda Stepping Test (FST) have assisted as bedside examinations of the VSR; however, direct measurement of the VSR, separate from other systems, is relatively difficult given the complexity of the neural connections between the vestibular nuclei, brainstem, and spinal cord (Baloh and Honrubia, 2001).

Barany (1907) first reported an inability to maintain Romberg stance with eyes closed in patients with unilateral peripheral vestibular dysfunction; the individuals frequently fell in the direction of the slow component of nystagmus (paretic side). In addition, Barany documented the clinical sign of past pointing, or upper extremity drift due to peripheral vestibular system imbalance in the direction of the slow component of induced nystagmus post–caloric irrigations (Barany, 1910). During the past pointing task, patients extend both arms and place their index fingers on the examiner's fingers. Then, with eyes closed, the patients raise their arms 90° and attempt to replace their index fingers on the examiner's fingers. Barany (1910) noted that after a cool caloric irrigation, a patient would past point toward the stimulated ear (i.e., the weaker side) due to decreased spontaneous firing rate, or inhibitory response of the vestibular nerve on the side of the irrigation. An opposite effect would occur during warm water irrigations, as the patients would past point away from the stimulated ear (i.e., the weaker side) due to the increased spontaneous firing rate, or excitatory response of the vestibular nerve on the stimulated side. The past pointing sign (i.e., drifting of upper extremities toward the weaker side) was documented in patients with acute peripheral vestibular loss; however, variable results were noted as patients proceeded through the central compensation process (Barany, 1910).

Unterberger (1938) was the first to study "deviations in walking" due to an induced vestibular response or unilateral pathology of the peripheral vestibular system. These discoveries lead to the development of the Unterberger test that was studied and popularized by Fukuda (1959) and named the Fukuda Stepping Test. The FST was designed to identify labyrinthine dysfunction by asking patients to stand in an upright position, extend both arms, and walk in place for 50–100 steps with eyes closed. Individuals with normal vestibular function tend to travel forward while performing the FST (Bonanni and Newton, 1998). Fukuda (1959) noted that in the presence of a significant difference in peripheral vestibular function, the patient would deviate (earth-vertical axis rotation) from their original position; similar to past pointing results, this rotation corresponded with the direction of the slow component of nystagmus. It was hypothesized that the rotation was derived from a tonic imbalance within the peripheral vestibular end organs. During the stepping task, the tonic imbalance was interpreted centrally as a false rotation toward the unaffected side resulting in a compensatory reflexive movement in the yaw plane toward the affected side.

Although the original work by Fukuda (1959) implied that a rotation greater than 30° indicates a peripheral vestibular system dysfunction on the side of the rotation, there have been discrepancies with these findings. Rotations post-FST have been documented in healthy individuals (Bonanni and Newton, 1998), perhaps due to hand dominance (Reiss and Reiss, 1997), as well as individuals with labyrinthine dysfunction (Peitersen, 1964, 1967; Moffat et al, 1989). Parallel to the past-pointing test, the accuracy of the FST to identify the side of peripheral vestibular pathology is compromised as the patient moves through the central compensation process. Overall, the FST has poor sensitivity for identifying unilateral peripheral vestibular weakness when compared to gold standard peripheral vestibular assessment, caloric irrigations using a cutoff value of >25% for reporting unilateral weakness (UW) (Honaker et al, 2009).

In a previous retrospective review (Honaker et al, 2009), we evaluated the sensitivity and specificity of the standard FST and a head shaking variation for identification of a peripheral vestibular system lesion in 736 chronic dizzy patients. We used the commonly accepted criterion value (UW $\geq$ 25%) based on Jongkees' formula (Jongkees et al, 1962) for reporting reduced vestibular response. Receiver operating characteristic (ROC) curves analysis and area under the curve (AUC) indicated no significant benefit (comparison of AUC, p-value = 0.860) to performance from the head shaking variation compared to the standard FST task. We concluded that the FST with and without head shake component was not sensitive enough to replace caloric irrigations, nor useful as a reliable screening tool for peripheral vestibular asymmetry in chronic dizzy patients. However, the level of unilateral weakness required before the FST is of clinical use was not determined. Therefore, the purpose of this technical report is to further evaluate the performance of the FST as a function of the severity of caloric asymmetry in chronic dizziness patients. We hypothesized that as caloric asymmetry (UW%) increases, the overall diagnostic performance of the FST with and without the head shaking component will improve.

METHODS

FST results from 736 consecutive chronic (i.e., symptom complaints $\geq$ eight weeks) balance disorder patients (315 males, 421 females, 15–89 yr) were collected. Patients who were unable to perform the Romberg test were excluded from participation. In addition, patients were excluded if they had any prior surgery or ongoing pain from the hips down.

The standard FST and FST with head shake were performed prior to bithermal caloric irrigations. Participants were asked to stand on a tiled floor with their feet shoulder-width apart, arms extended (parallel to the ground), eyes closed. Participants were then instructed to march in place for 50 steps. The FST was completed in shoes as long as the participant was wearing a low heel; anyone with an increased heel (>1 in) removed their shoes and was given slip-on foot covers with friction strips on the bottom. Patients were not blindfolded during the stepping task; however, an investigator carefully guarded the patient, moving with him or her from behind and slightly to the side so the face could be visualized. If the patient's eyes opened during the stepping task, the patient was asked to stop marching and the investigator re-instructed the patient to maintain eyes closed during the FST. Once the patient completed the FST, the final degree of deviation (i.e., turn angle) was recorded based on a grid on the tile floor. Next, without the patient opening his or her eyes, the patient repeated the FST after the examiner rotated his or her head 20° to the right and left of center for 10–15 sec at a frequency of 3–4 Hz; the magnitude of the head rotation was estimated by the examiner, but no rate sensor was used. Open loop bithermal (44 and 30°C) caloric irrigations were performed on all participants; unilateral weakness was calculated using Jongkees' (Jongkees et al, 1962) formula.

To explore the overall performance of FST with and without the head shaking component as compared to severity of caloric asymmetry, we reanalyzed the previously published data (Honaker et al, 2009). Specifically, ROC curve analysis was performed to determine the performance of FST (with and without head shake) in identifying peripheral vestibular paresis as compared to gold standard outcomes of unilateral weakness for the following four severity categories: 0–24% UW (normal vestibular paresis), 25–50% UW (mild vestibular paresis), 51–75% UW (moderate vestibular paresis), and 76–100% (severe vestibular paresis). Therefore, in this technical report, caloric irrigation UW% was used to determine the approximate severity of peripheral vestibular system hypofunction, corresponding with test accuracy from the FST for identifying peripheral vestibular dysfunction. The development of the vestibular paresis groups was based on the work by Beynon et al (1998), evaluating the performance of the head impulse test (a VOR bedside test) as compared to caloric UW severity. It should be noted that the state of physiologic compensation was not considered in the reanalysis of this data. The reason for this omission is that a previous review (Shepard et al, 1994) of a portion of this data (n = 701) found no statistically significant correlation between measures of static and dynamic compensation (spontaneous and positional nystagmus, directional preponderance from caloric irrigations, and asymmetry value from rotary chair) and the FST in any form. Thus, the measures of compensation demonstrated no explanation for the variability in the FST (with or without headshake). Only the findings of caloric asymmetry were significantly correlated to the results of the FST.

Therefore, we reanalyzed the FST results based on the four categories of UW, in the following manner:

1. Standard FST—turn toward the weaker labyrinthine side
2. Standard FST—independent of turn direction
3. FST following head shake—turn toward the weaker labyrinthine side
4. FST following head shake—independent of turn direction

The FST (with and without head shake) optimal criterion values (cut points) for the angle of rotation were identified based on ROC analysis for each of the gold standard outcomes of UW (UW 0–24%, UW 25–50%, UW 51–75%, UW 76–100%). The ROC space is comprised of a trade-off between sensitivity (true positive rate or ability to identify those with unilateral peripheral vestibular paresis, without missing anyone) and false positive rate (falsely identifying someone with a unilateral peripheral vestibular paresis) or 1-specificity (specificity is the ability to identify those without unilateral peripheral vestibular paresis, without falsely identifying anyone). All possible prediction outcomes of sensitivity and 1-specificity for FST angle of rotation were plotted along the ROC curve as specific points along the curve. The best possible prediction of sensitivity and 1-specificity was selected as the optimal cut-point value for angle of rotation; this value represents the point along the curve closest to the upper left-hand corner of the ROC curve space. Ideally, cut-point values with 100% sensitivity and 0% false positive rate (i.e., 100% specificity) represent the best possible performance of a test (Turner and Nielsen, 1984). Therefore, sensitivity, specificity, and likelihood ratios (i.e., confidence measure of sensitivity divided by false positive rate signifying that a positive test result correctly indicates unilateral peripheral vestibular paresis) were calculated at these criterion values.

AUCs were calculated and compared to determine the overall accuracy of FST (with and without head shake) as compared to increased severity of caloric asymmetry results. AUCs closer to 1.0 represent best diagnostic accuracy, whereas scores closer to 0.5 represent poor diagnostic performance. P-values <0.05 were considered statistically significant; all analyses were performed using PAWS (Version 18, SPSS Inc., Chicago, IL) and MedCalc (Version 11.6.1.0, MedCalc Software, Mariakerke, Belgium).

RESULTS

Results obtained from two Midwestern tertiary hospitals on 736 chronic dizzy participants were included in the analysis of the standard FST independent of turn toward the weaker labyrinth, with 701 participating in the FST following head shaking task independent of turn toward the weaker labyrinth as previously reported by Honaker et al (2009). Time from onset of symptoms was ≥8 wk for all 736 participants; however, the specific details on length of time were not collected for analysis. Of those participants who performed the standard FST, 283 turned toward the side of the caloric UW, and of those who performed the FST following head shake, 293 turned toward the side of the caloric UW. The distribution of unilateral weakness found on caloric testing is shown in Figure 1. The total sample (n = 736) included a range of results from 0 to 100% UW. Of those patients, 523 (71%) had 0–24% UW, 147 (20%) had 25–50% UW, 44 (6%) had 51–75% UW, and 22 (3%) had 76–100% UW.

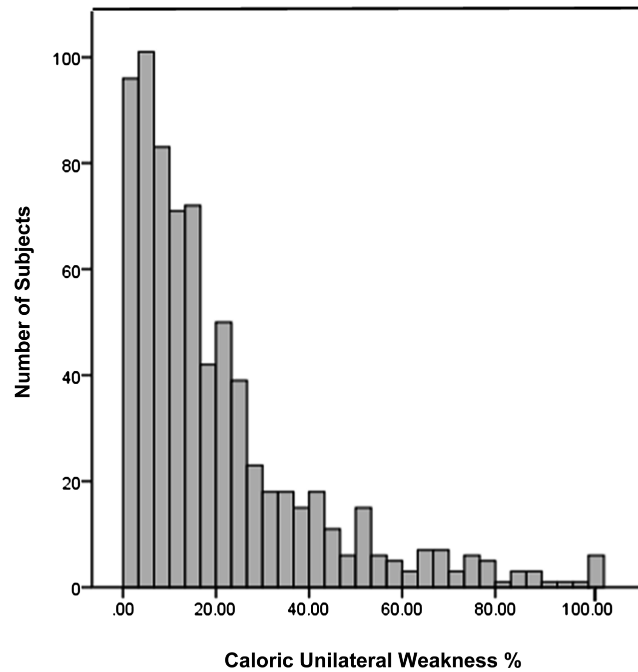

Figure 1. Range of caloric results for total subjects (n = 736).

The sensitivity, specificity, and test accuracy (AUCs, likelihood ratios) for standard FST and FST following head shake for identifying peripheral vestibular hypofunction based on rotation toward the side of caloric UW are reported on Table 1. Derived from ROC analysis, the performance parameters of the FST (with and without the head shake component) increased with the level of UW severity. FST following head shake with turn toward the weaker labyrinth as compared to severe caloric asymmetry outcomes (76–100% UW) demonstrated the largest AUC (0.84); sensitivity and specificity values were at 67 and 73%, respectively, and likelihood ratio was at 2.48. The cut-point value was indicated at 37.50° of rotation to the side of the paresis. The standard FST, turn toward the weaker labyrinth also demonstrated a large AUC (AUC = 0.81, sensitivity = 67%, specificity = 76%, likelihood ratio = 2.79) with cut-point value of 35° of rotation. There was no significant improvement in performance between standard FST and FST following head shake in the severe caloric UW group (comparison of AUC, p-value = 0.76).

Poor diagnostic performance was noted for FST results (with and without head shake) as compared to caloric irrigation outcomes for the mild (25–50% UW) peripheral vestibular paresis group (standard FST AUC = 0.41, sensitivity = 28%, specificity = 66%, likelihood ratio = 0.82; FST following head shake AUC = 0.45, sensitivity = 32%, specificity = 54%, likelihood ratio = 0.69), with cut-point values of 22.5° of turn and 17.5° of turn, respectively.

Table 1. Receiver Operating Characteristic (ROC) Curves Analysis of Fukuda Stepping Test (FST) Results with Turn toward the Weaker Labyrinth as Compared to Severity of Unilateral Weakness (UW) Outcomes

	(Total subjects)	AUC	Cut point	Sensitivity	Specificity	Likelihood ratio
			Normal caloric UW (0–24%)			
Standard FST	202/283	0.52	12.5	0.46	0.6	1.15
FST following head shake	201/293	0.5	12.5	0.44	0.58	1.05
			Mild caloric UW (25–50%)			
Standard FST	63/283	0.41	22.5	0.28	0.66	0.82
FST following head shake	65/293	0.45	17.5	0.32	0.54	0.69
			Moderate caloric UW (51–75%)			
Standard FST	12/283	0.62	17.5	0.67	0.60	1.68
FST following head shake	18/293	0.55	12.5	0.5	0.58	1.19
			Severe caloric UW (76–100%)			
Standard FST	6/283	0.81	35.0	0.67	0.76	2.79
FST following head shake	8/293	0.84	37.5	0.67	0.73	2.48

Note: Cut-point score represents Fukuda Stepping Test (FST) degree of turn suggesting unilateral peripheral vestibular hypofunction as indicated by gold standard outcome of UW%.

Slightly improved performance was noted for the moderate (51–75% UW) peripheral vestibular paresis group (Standard FST AUC = 0.62, sensitivity = 67%, specificity = 60%, likelihood ratio = 1.68, cut-point value 17.5° of turn; FST following head shake AUC = 0.55, sensitivity = 50%, specificity = 58%, likelihood ratio = 1.19, cut-point value 12.5° of turn). Chance performance was observed for the normal (0–24% UW) peripheral vestibular asymmetry group (Standard FST AUC = 0.52, sensitivity = 46%, specificity = 60%, likelihood ratio = 1.15, cut-point value 12.5° of turn; FST following head shake AUC = 0.5, sensitivity = 44%, specificity = 58%, likelihood ratio = 1.05, cut-point value 12.5° of turn).

ROC analysis of FST results (with and without head shake) independent of turn toward the weaker labyrinth as compared to the severity of unilateral weakness indicated poor diagnostic performance (AUC range = 0.47–0.54) regardless of caloric UW severity (see Table 2). However, it should be noted that for ROC analysis of standard FST or FST following head shake, fair specificity was observed (range = 71–79%) as compared to the mild, moderate, and severe UW groups.

DISCUSSION

When evaluating the performance of a clinical test of the peripheral vestibular system, one should set the criterion (cut-point value) and test parameters to maximize sensitivity and specificity. Ideally, this will yield an accurate screening measure that correctly identifies those with peripheral vestibular dysfunction and those without. The relatively poor sensitivity of the FST as compared to ≥25% UW reported from Honaker et al (2009), and fair sensitivity documented by others (Moffat et al 1989; McCaslin et al 2008; see Table 3) suggests that it may not be suitable as a screening measure for unilateral peripheral vestibular dysfunction. The slight differences in sensitivity obtained between these reports may be due to the caloric irrigation criterion value used to define significant unilateral caloric weakness, the methods used to perform the FST, the patient population

Table 2. Receiver Operating Characteristic (ROC) Curves Analysis of Fukuda Stepping Test (FST) Results Independent of Turn toward the Weaker Labyrinth as Compared to Severity of Unilateral Weakness (UW) Outcomes

	(Total subjects)	AUC	Cut point	Sensitivity	Specificity	Likelihood ratio
			Normal caloric UW (0–24%)			
Standard FST	523/736	0.51	2.5	0.44	0.56	1.0
FST following head shake	499/701	0.51	7.5	0.45	0.60	1.13
			Mild caloric UW (25–50%)			
Standard FST	147/736	0.47	22.5	0.25	0.76	1.04
FST following head shake	139/701	0.47	22.5	0.25	0.71	0.86
			Moderate caloric UW (51–75%)			
Standard FST	44/736	0.52	27.5	0.34	0.76	1.42
FST following head shake	41/701	0.50	22.5	0.34	0.72	1.21
			Severe caloric UW (76–100%)			
Standard FST	22/736	0.53	37.5	0.37	0.79	1.76
FST following head shake	22/701	0.54	32.5	0.36	0.76	1.50

Note: Cut-point score represents Fukuda Stepping Test (FST) degree of turn suggesting unilateral peripheral vestibular hypofunction as indicated by gold standard outcome of UW%.

Table 3. Comparison of Bedside Vestibular Evaluations (head shake, head thrust, and Fukuda Stepping Test) for Identifying Unilateral Vestibular Hypofunction

Authors	Bedside assessment *n*	Disorder	Sensitivity	Specificity
Hain et al (1987)	Head shake *n* = 6	Complete UVH	100%	43%
Fujimoto et al (1993)	Head shake *n* = 259	UVH > 20%	50.21%	73.18%
		UVH > 40%	64.36%	71.69%
		UVH > 60%	68.33%	70.68%
		UVH > 80%	77.14%	70.14%
Halmagyi and Curthoys (1988)	Head thrust *n* = 12	Complete UVH	100%	100%
Schubert et al (2004)	Head thrust *n* = 79	UVH >25%	71%	82%
Honaker et al (2009)	Fukuda Stepping Test *n* = 736	UVH ≥ 25%	61%	61%
McCaslin et al (2008); D.L. McCaslin, pers. comm., February 15, 2011	Fukuda Stepping Test *n* = 61	UVH > 23%	70%	59%
Moffat et al (1989)	Fukuda Stepping Test *n* = 100	UVH (unspecified %)	71%	n/a*

Note: UVH = unilateral vestibular hypofunction.

*100 patients with unilateral acoustic neuroma were included in the analysis; a comparison group of individuals without acoustic neuroma was not included in the analysis.

recruited for the studies, and the state of compensation of the participants.

Conversely, based on the results reported herein one could argue the FST may provide some benefit to clinicians, in that a >30° rotation may raise the suspicion of a *severe* unilateral weakness given the increase in test performance (AUCs = 0.81–0.84). This improved sensitivity reported for the severe UW group may be explained by the physiologically inadequate peripheral vestibular system (i.e., tonic imbalance) interpreted as a false rotation toward the stronger side, centrally generating a compensatory rotation toward the weaker labyrinth. The sensitivity of the FST in detecting mild to moderate vestibular weakness is likely poor due to the presence of some level of residual functioning (Beynon et al, 1998) that may provide adequate input for the VSR. With increased residual peripheral vestibular function on the impaired side, the remaining tonic activity may be enough to allow normal to near normal performance on the FST. However, this may also account for the fair sensitivity and specificity values obtained for the severe UW group, as some individuals in the severe group had remaining low-frequency tonic function of the peripheral vestibular system as indicated on caloric irrigation testing (Beynon et al, 1998). However, in the presence of increased sensitivity for the severe UW group, it is uncertain what information this would provide to a clinician. A turn greater than 30° may imply a unilateral vestibular hypofunction toward or away from the turn, or a false positive result. Even for those individuals who obtained 100% caloric unilateral weakness, the FST results did not correlate with a turn toward the weakness. It should be noted that six individuals had a caloric UW of 100%, and of these six individuals, all deviated (rotated) from starting position during the standard FST and FST following head shake; however, only three had FST turns in the direction of the caloric UW. The discrepancies in these results are similar to those found throughout the literature indicating inconsistencies in direction of rotation either toward or away from the side of lesion (Peitersen, 1964, 1967). Peitersen (1964) described an increased angle of rotation (90° or more toward the affected ear) during a stepping test in 14 patients who had undergone labyrinthectomy or had complete etiologic unilateral vestibular hypofunction as identified by absent caloric response in the affected ear. However, no correlation was noted between the direction of rotation in the stepping test and the side of the affected ear for patients with unilateral acoustic neuroma or vestibular neuritis (i.e., varying degrees of unilateral weakness).

The clinical usefulness of the FST in the identification of a unilateral peripheral vestibular lesion is further questioned when comparing its performance versus other bedside vestibular assessments (see Table 3). The increased frequency of a positive FST in the presence of severe unilateral peripheral vestibular pathology is not as sensitive as head thrust or head shaking assessments in similar chronic dizzy patient populations (Hain et al, 1987; Halmagyi and Curthoys, 1988; Fujimoto et al, 1993; Schubert et al, 2004). The reason for this may be due to complexity of the connection between the vestibular nuclear complex and motor neurons of the VSR versus the VOR. In addition, measurement of the VSR is highly contingent upon neck stretch receptor input and otolith function for head and body orientation (Fetter and Dichgans, 1996; Baloh and Honrubia, 2001; Gleason, 2008). On the other hand, the head thrust or the head shaking test directly stimulate the peripheral vestibular system, thus enabling a direct observation of the VOR activity. This is arguably a less complex response than observing the impact of labyrinthine deficit on postural control.

Despite the addition of a high acceleration head shake task to FST, the results were not significantly different from the standard FST task. The inclusion of a head shake condition to the standard FST was hypothesized to produce an increase of neural activity at the level of the velocity storage integrator within the vestibular nuclei, in hopes of producing nystagmus (asymmetrical VOR response) and unsteadiness (increased extensor activity on the stronger side; asymmetrical VSR tone) (Panosian and Paige, 1995). This finding further concludes that FST following head shake is not clinically useful to further discern a vestibular asymmetry.

It should again be noted that a limitation of this work, first identified in Honaker et al (2009) and a previous analysis of the data (Shepard et al 1994), is that there were no correlations with FST and traditional indicators of the state of compensation. While the use of the FST in the acute (symptom complaints <2 wk) patient population with the addition of analysis of the state of compensation has not been reported, it is anticipated that test performance would not surpass other bedside evaluation tools as described in Table 3. Therefore, from a clinical standpoint, it is not suggested to use the FST as a screening tool for peripheral vestibular asymmetry.

Acknowledgments. The authors wish to thank Robin Criter and Jameson Hofker for their assistance in preparing this manuscript.

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