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Head-up Tilt Test May Be Useful for Determining Permission of Flight for Regular Passenger Aircraft Pilots with Vasovagal Syncope

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Abstract: To determine the permissibility of piloting an aircraft with vasovagal syncope (VVS) is a complex responsibility, because it is difficult to evaluate VVS quantitatively. There are no clear guidelines for aircraft pilots with VVS. In some facilities, Head-up Tilt Test (HUTT) is used to determine its reproducibility and treatment effect. In most cases, permission is dependent on the strict examinations by specialists and judgement of the committee established for each country. Therefore, we assessed pilots with VVS and designed an algorithm of permission for piloting an aircraft. Here, we describe 7 consecutive regular passenger aircraft pilots with VVS who were restricted to fly. All patients were men and their mean age was 37 years. All pilots were permitted to fly after at least two or more tilt-tests. The observation period was two years after flight permission. None of the pilots in the present study fainted after receiving flight permission. We can make a risk stratification to determine hypotensive susceptibility by multiple tilt tests. Based on the results of multiple HUTT, we can more quantitatively make the judgement as to whether the pilot's VVS is well managed.

Key words: vasovagal syncope, pilot, head-up tilt test

Introduction

Syncope is defined as a sudden loss of consciousness associated with a loss of postural tone in which the patient recovers, spontaneously. There are various causes of syncope; the prognosis of syncope differs according to the cause¹⁻³⁾. Reflex syncope is the most common type of syncope among which vasovagal syncope (VVS) is particularly frequent. Having VVS while driving a car endangers personal and public safety; thus, it is necessary to consider the restriction of driving privileges to protect both the individual with syncope and the public^{4,5)}. In Japan, patients with recurrent syncope have driving restrictions based on the Guidelines for the Diagnosis and Management of Syncope; Japanese Circulation Society (JCS) published online in 2012⁶⁾. Syncope

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in passenger aircraft pilots has more dangerous implications for personal and public safety and may cause catastrophic aircraft accidents. Determining whether a pilot with VVS is fit to fly an aircraft is a huge responsibility; however, the quantitative evaluation of VVS is difficult. There are no clear guidelines for aircraft pilots with VVS. In some facilities, the head-up tilt test (HUTT) is used to evaluate the reproducibility and treatment effect for VVS. [HUTT was originally aimed at reproducing VVS through the maintenance of a prolonged and static upright position, and the test was recently proposed as a diagnostic tool for hypotensive susceptibility VVS.] In most cases of passenger aircraft pilots with VVS, permission to fly depends on strict examinations by specialists and the judgment of a committee established by each country. Therefore, we designed an algorithm for judging of the condition of VVS, observed 7 pilots with VVS, and give a detailed description of two cases of those 7 pilots who were permitted to fly.

Methods

Patient populations

We studied regular passenger aircraft pilots with VVS who visited the Showa University Hospital for syncope from January 2009 to December 2017. Patients experiencing typical non-syncopal events, namely other disorders with impairment or loss of consciousness resembling syncope, (such as transient ischemic attacks, metabolic disorders, epilepsy, intoxication, cataplexy, drop attacks, and psychogenic disorders) were excluded. Furthermore, we also excluded patients with head trauma without a syncopal episode or those with a prolonged loss of consciousness disorder. Pilots with VVS were prohibited from piloting an aircraft immediately after fainting. The flight permission was dependent on the strict examinations by specialists and judgement of the committee established by Ministry of Land, Infrastructure, Transport and Tourism. We evaluated the condition of VVS by HUTT. At least two negative HUTTs were confirmed before permission and HUTT was conducted every 6 months after permission.

The observation period was two years after flight permission.

Diagnosis of VVS

At the first visit, pilots diagnosed with epilepsy, structural cardiovascular disease, arrhythmia, and metabolic disease were excluded. We inquired about posture, status, obvious triggers and prodromal symptoms at the time of transient loss of consciousness. We initially instructed all pilots diagnosed with VVS in tilt training (which is training to keep leaning against the wall for 15 minutes standing) as an outpatient. And then we provided them lifestyle guidance and patient education regarding situations in which it was easy to faint, the importance of eating breakfast, and not to drink on the day before work.

HUTT Protocol at our Hospital

After 4 h of fasting, all individuals were tested on a tilt table with a foot plate support. Restraining belts were placed around the chest and thighs. HUTT was administered by at least two doctors. The test was preceded by 20 min of observation of the patient in the supine



Fig. 1. The test was preceded by 20 min of observation of patients in the supine position. A 70° angle of tilt was used (Figure 1), and the test lasted for a maximum of 70 min with drug loading. Blood pressure was continuously monitored via noninvasive blood pressure measurements.

The HUTT Protocol at our Hospital

1. Valsalva maneuver and carotid sinus massage are done in a supine position.
2. Valsalva maneuver and carotid sinus massage are done in a standing position.
3. Standing load for 30 minutes at a 70° slope.
4. Standing load for 2 minutes, after rapid injection of ATP 0.1mg/kg and then 0.2 mg/kg.
5. Standing load for 15 minutes, after a 25% increase in heart rate with of 0.01 µg/kg/minute of Isoproterenol.
6. Standing load for 15 minutes, after sublingual administration of 0.3 mg of nitroglycerin.

Fig. 2. HUTT protocol in this study. Valsalva maneuver, carotid sinus massage, ATP injection, Isoproterenol load and sublingual administration of nitroglycerin were done.

position. A 70° angle of tilt was used (Figure 1), and the test lasted for a maximum of 70 min with drug loading in accordance with the Westminster, Isoprenaline and Nitroglycerine protocols (Figure 2). Valsalva maneuver and carotid sinus massage were done for 15 seconds each. And each drug loading was done according to the protocol (Figure 2). Blood pressure was continuously monitored via noninvasive blood pressure measurements. A positive HUTT was defined as syncope or severe presyncope (a state of lightheadedness associated with at least one of the following symptoms: partial loss of postural tone, decreased vision, slow response to verbal stimuli, or nausea) accompanied by marked hypotension (systolic blood pressure <80 mm

Table 1. Characteristics of this study

	Age	Sex	Diagnosis	Prodromal symptoms	Fainting position	Trigger	Tilt training	Permission of flight	Recurrence
case 1	29	male	VVS	palpitations	standing/sitting	gastro-enteritis	everyday	permitted	no
case 2	33	male	VVS	nausea	standing	lack of sleep	everyday	permitted	no
case 3	36	male	VVS	dizziness	standing	dehydration	everyday	permitted	no
case 4	42	male	VVS	dizziness	standing	none	1/week	permitted	no
case 5	64	male	VVS	none	sitting	none		Retired without permission	
case 6	31	male	VVS (injection-induced)	dizziness	supine position	injection	none	permitted	no
case 7	26	male	VVS	dizziness	standing	gastro-enteritis	3 times a week	permitted	no

VVS, vasovagal syncope

Hg) or bradycardia <40 bpm or both.

Results

Patient characteristics

Here, we describe seven consecutive regular passenger aircraft pilots with VVS who had flight restrictions. The pilots had no diseases limiting their ability to fly, and no abnormal examinations, including neurological examination, blood test, electrocardiogram, electroencephalogram, Holter-monitoring, echocardiography, and brain MRI. Table 1 details the characteristics of the seven pilots. All pilots were men with a mean age of 37 years. All pilots, except case 5, had prodromal symptoms, including dizziness in four, palpitation in one, and nausea in one. With the exception of case 6, all patients underwent tilt training. Unfortunately, the time of retirement of case 5 came prior to receiving flight permission. As a result of our judgment, all patients, except case 5, were permitted to fly by the committee. We designed an algorithm for pilots with VVS (Figure 3), and categorized the 7 cases accordingly: Group 1, Cases 2, 3, 4, and 7; Group 2, Case 1; and Group 3, Case 5. All pilots, including those previously examined in other hospitals, were permitted to fly after two or more negative HUTTs. Case 6 fainted after a specific trigger, such as the injection; therefore, he received only lifestyle guidance, and he was permitted to fly, although not as per the algorithm. All aviators except case 5 were judged to be suitable for flight following lifestyle guidance and daily tilt training, and none of them fainted after flight permission was granted.

Case reports

We describe the details of two typical cases of regular passenger aircraft pilots.

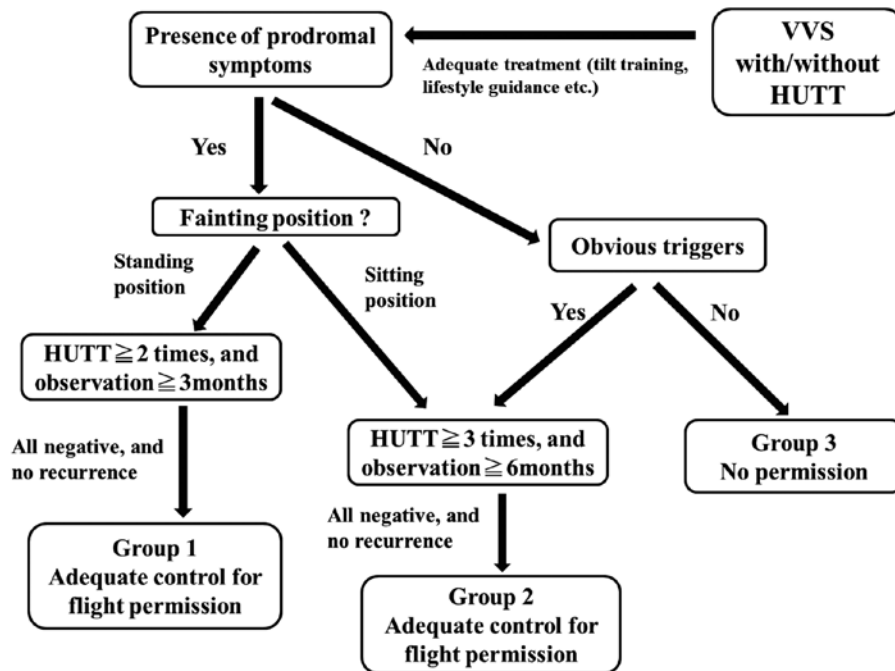
Algorithm for Pilots with VVS at our Showa University Hospital

Fig. 3. Algorithm to judge whether VVS was in adequate control for flight. When applied to group 1 or 2, pilots could not be permitted until it was confirmed that consecutive HUTTs were negative and there was no recurrence within the observation period.

【Case 1】

A 29-year-old man who was a regular passenger aircraft pilot had fainted twice in the past (before becoming a pilot). He lost consciousness for a few seconds while in a standing position after feeling nauseous when boarding a plane as a passenger at the age of 19 years. While suffering from gastroenteritis at the age of 24 years, he lost consciousness for a few seconds in a sitting position while studying. He immediately recovered consciousness both times. He became a regular aircraft pilot at the age of 25 years. At the age of 28 years, he lost consciousness for a few seconds in a standing position during a pre-flight meeting after experiencing palpitations. There was no obvious abnormality in his general examination, and he was previously diagnosed with VVS at another hospital. During his positive HUTT, he fainted after standing for 18 min. The type of VVS induced during his HUTT was cardio-inhibitory (CI). A re-examination was required at our hospital because he underwent HUTT without breakfast or lunch in the previous hospital. In addition, he underwent tilt training every day since his first visit. The first HUTT at our hospital was negative, and the second and third HUTTs, conducted at 4 and 6 months, respectively, were also negative. Therefore, we judged his VVS to be under control, and he was permitted to pilot an aircraft. He has not lost consciousness since receiving the permission to fly, and HUTTs conducted every 6 months have been negative.

【Case 2】

A 33-year-old man was a regular passenger aircraft pilot. Although he had no previous experience, he obtained his license as a regular passenger airplane pilot in Japan when at the age of 32 years. At a pre-flight meeting, he lost consciousness for approximately 20 s in a standing position after feeling nauseous. Therefore, he was immediately suspended from flying, and a general examination was performed at another hospital. Because no abnormal findings were noted, he was diagnosed with VVS. HUTT was conducted (standing load 15 min, isoproterenol load), and the result was negative. He was referred to our hospital for the treatment of VVS. The first HUTT conducted at our hospital was positive. CI type was induced in a standing position after 0.1 mg/kg of adenosine triphosphate test (ATP) load. Therefore, we instructed him to undergo tilt training on an outpatient basis. The second HUTT conducted at 3 months was also positive after he fainted again with standing load alone. However, a re-examination that was performed on the same day, with the patient wearing girth band and elastic stockings, was negative. Meanwhile, he was continued on tilt training. The third HUTT conducted with the patient wearing only elastic stockings was negative, and the fourth HUTT without girth band and elastic stockings was also negative. We judged that tilt training was effective and that his VVS was adequately managed; therefore, the committee permitted him to resume flying. He has not lost consciousness since gaining permission to fly, and HUTTs conducted every 6 months were all negative.

Discussion*Main findings*

We treated seven regular passenger aircraft pilots with VVS. All patients except case 5 were permitted to pilot an aircraft. The time of retirement for case 5 came prior to receiving the permission to fly. Multiple HUTTs can be utilized as a risk stratification tool to determine hypotensive susceptibility. Quantitative inspections, such as HUTT, may be necessary for pilots with VVS. None of the pilots in the present study fainted after receiving flight permission.

Permission to pilot a regular aircraft

The flight of a regular passenger aircrafts is required to be handled by the captain and a co-pilot (three pilots during long distance flights). Most pilots are very careful regarding their health status and receive frequent medical examinations according to the manual for Aviation Medical Examinations. Thus, the permission for boarding is determined under more stringent conditions compared with the permission for driving a car. However, it is difficult for pilots to avoid stress, change their posture, or perform isometric physical counter pressure maneuvers while in flight. Granting the permission of flight depended on strict examinations by medical specialists and the judgment of a committee established by each country. Because there were no useful examinations to determine the permissibility to pilot an aircraft with VVS, we designed an HUTT algorithm for pilots with VVS. It was reported that there was daily variance in HUTT, while it had good reproducibility within a day⁶⁻⁹⁾. Therefore, with this algorithm, it is necessary

to confirm multiple negative tilt tests for boarding.

Pilots with VVS could be divided into two groups according to the presence of prodromal symptoms. We determined that pilots without prodromal symptoms needed extra care prior to granting permission to pilot an aircraft. In addition, the pilots could be divided according to their fainting position and obvious triggers. Obvious triggers included events such as gastroenteritis, injection, and long-term fasting. More care is necessary for pilots who faint in a sitting position and pilots without obvious triggers. As shown in Figure 2, we designed an algorithm based on the results of HUTT. Furthermore, HUTT played an important role in determining flight permission and thus, pilots with VVS living a well-regulated life.

A previous report supports our results¹⁰. Two pilots in the U.S. experienced recurrent episodes of VVS, one with triggers and one without triggers, and both pilots had positive HUTTs. The first case was trigger-defined VVS, and he was disqualified from high-performance platforms because of his positive HUTT, and the second case was disqualified from all platforms, irrespective of his HUTT result, because his syncopal episodes did not have a definite trigger.

Having syncope while driving a car endangers personal and public safety. There are guidelines and reports on driving of patients with syncope¹¹⁻¹⁴. This is same for piloting a regular aircraft. We thought that a clear judgment criterion for flight permission is necessary, like the driving of a car, and designed the algorithm.

Preventing syncope while piloting an aircraft

Several mechanisms or factors might trigger VVS while piloting an aircraft, including being in a passively seated position without muscle tension (enhances venous pooling in the legs), pre-existing dehydration or intravascular depletion, the warm environment of the aircraft (leads to cutaneous vasodilatation), and strong emotional stimulation^{4, 12}. Treatment for preventing VVS while piloting an aircraft comprises avoiding triggering events and reassurance. Education is important for reducing the risk of both recurrent syncope and individual and public harm. Most pilots suffering from syncope while flying an aircraft had some warning in the form of prodromal symptoms prior to the syncopal event¹⁵. A greater awareness of these symptoms can help pilots in controlling their triggers while flying and avoiding catastrophic traffic accidents. HUTT is important both as a place for patients to understand prodromal symptoms and as a place to receive education for lifestyle guidance to prevent syncope. In general, taking frequent breaks while piloting an aircraft, maintaining an optimal environment in the aircraft, and consuming appropriate fluids and salts are recommended for patients with VVS.

Limitations

Our study has some limitations. First, we included a small number of patients; therefore, further studies are necessary to confirm the utility of HUTT for granting permission to pilot an aircraft. Second, inclusion and exclusion criteria need to be defined prior to the widespread application of this technique.

Conclusion

We constructed a risk stratification method to determine hypotensive susceptibility by conducting multiple HUTTs. Managing VVS in pilots can be more quantitatively judged based on the results of multiple HUTTs.

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Conflict of interest disclosure

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