Subjective Visual Vertical in Post Total Stapedectomy with Tailored-Made Polyethylene Strut

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Objective: *To compare the subjective visual vertical (SVV) in otosclerotic patients before and after total stapedectomy with tailored-made polyethylene strut.*

Material and Method: *Thirty-eight otosclerotic patients who underwent total stapedectomy with tailored-made polyethylene strut between November 1, 2013 and December 31, 2014 were recruited.*

Results: *Nine out of 38 patients (23.7%) had abnormal SVV at 24 hours after total stapedectomy with tailored-made polyethylene strut. The number had decreased to 3/31 patients (9.6%) one month and 2/22 patients (9.0%) two months after surgery.*

Conclusion: *Evidence of otolithic organ injury has been found after total stapedectomy with tailored-made polyethylene strut. Nevertheless, the injuries do not cause clinical symptoms. Patients recover quickly with good result in hearing gain after surgery.*

Keywords: *Stapedectomy, Subjective Visual Vertical, Polyethylene Strut*

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Otosclerosis is not an uncommon disease in Thailand. Otosclerosis is a hereditary disorder characterized by disordered resorption and deposition of enchondral bone of the otic capsule. This pathology causes impairment of stapes movement and brings patient with conductive hearing loss. John Shea initiated a basic principle of surgical correction in 1956[1], which is the core method up until now. The correction of stapes fixation is by opening the fixed footplate then connects the incus to the oval window with stapes prosthesis. Since 1956, there have been variations of procedures and prosthesis in term of benefits.

Surgery for otosclerosis succeeds by either total stapedectomy or stapedotomy. Many researches showed equal results in hearing gain after surgery between stapedotomy and total stapedectomy[2,3]. Stapedotomy has become more popular because it is considered less invasive than total stapedectomy. However, most stapedotomy needs commercial stapes prosthesis, which is still expensive in Thailand. In our institute, for total stapedectomy, surgeons make a tailored-made prosthesis with two sizes of polyethylene tube (PE) 90 and 50, which is much cheaper.

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Significant complications of stapedectomy are infrequent[4]. However, postoperative vertigo is a common complication after stapes surgery, even in stapedotomy[5,6]. One of the causes of postoperative vertigo is injury to the otolithic organs. In total stapedectomy, surgeons have more chance to injure the otolithic organs when removing all footplate. The subjective visual vertical (SVV) is a measurement of angle of the luminous line between perceptual vertical and the true vertical (gravitational vertical). Deviation of SVV in patients with otolithic organs dysfunction is well known[7].

The present study concerned the effects on the SVV before and after total stapedectomy with tailored-made polyethylene stapes prosthesis and to analyze correlation between SVV result and the vertigo grading score.

Material and Method

Sample size was calculated using McNemar's test of equality of paired proportions. According to Böhmer and Mast[7], the difference in proportion between pre and post stapedotomy was 0.18. We calculated for type I error of 0.05 and power significant of 80%. To achieve the comparison, we decided to recruit 38 ears to determine the effects on the SVV before and after total stapedectomy with tailored-made polyethylene stapes prosthesis.

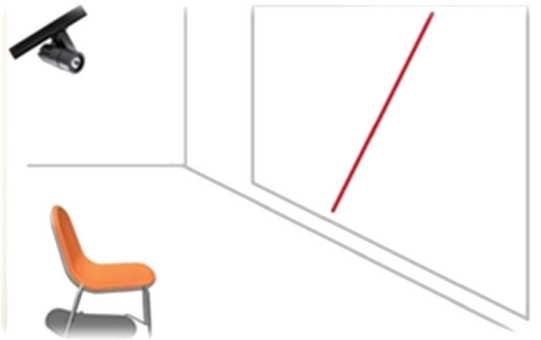

Fig. 1 Demonstration of room setting during SVV testing.

After approval by the Siriraj Ethic Committee (Si577/2013), 38 otosclerotic patients operated between November 1, 2013 and December 31, 2014 were enrolled to the study. The inclusion criteria were otosclerotic patients (above 18 years old) who underwent total stapedectomy with tailored-made polyethylene strut. Patients had normal SVV testing and no complaints of vertigo preoperatively.

Data records

Personal data, audiogram, SVV, vertigo grading, and intraoperative records, which were prosthesis length, number of attempts, and operative time were collected.

Subjective visual vertical (SVV)

Patients were tested in sitting position 2-metres away from the monitor in a dark room. An illuminated red line was easily rotated in a clockwise or counter-clockwise rotation while initial position of the bar was set randomly. Patients decided vertical position in six times. The average of perceptual vertical angles was calculated (Fig. 1).

Vertigo grading

The grades were as follows, grade I means no vertigo, grade II means feel dizzy but not hindering daily activities, grade III means patients need assistance in daily activities, and grade IV means disabling vertigo.

Surgical techniques

All patients in the present study underwent total stapedectomy. After entering middle ear space by elevating standard tympanomeatal flap, operative field was expanded by curetting part of tympanic bone while preserving the chorda tympani nerve. After securing stapedius tendon and testing of perilymphatic gusher, stapes was totally removed mechanically. Vein or perichondrium graft was placed covering oval window, then tailored-made polyethylene strut was placed between lenticular process and oval window as shown in Fig. 2.

Tailored-made polyethylene strut

The distance between lenticular process to footplate was measured by measuring rod. This would be the length of PE50, which was dressed in a half distance of 1 mm length beveled-PE90 part, as shown in Fig. 3 and 4.

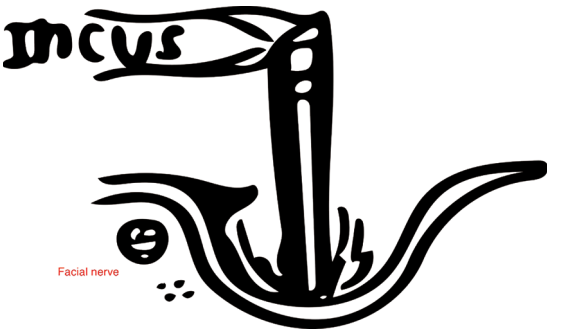

Fig. 2 Position of polyethylene strut placement.

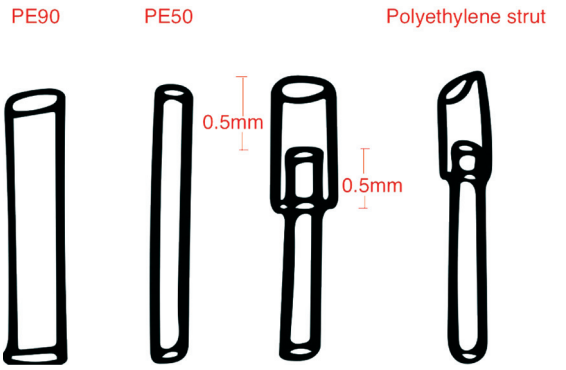

Fig. 3 Composition of polyethylene strut.

Fig. 4 Polyethylene strut.

Statistical analysis

Statistical analysis was performed with SPSS software, version 15 (IBM Corporation, Armonk, NY, USA). For continuous variables were summarized by mean ± SD and nominal variables were summarized by frequency and percentage. The SVV was tested for normal distribution as the determined by Kolmogorov-Sminov test. Comparisons on the SVV between pre and post total stapedectomy at 24 hours, one month, and two months (continuous variables) were performed using paired t-test. Spearman rank correlation was used to test for association of SVV and vertigo grading. The value of $p<0.05$ was considered to indicate a statistically significant difference.

Results

Thirty-seven patients with 38 ears were enrolled in the present study. Characteristics of the participants were 14 males (36.8%) and 24 females (63.2%), age ranged between 26 and 66 years old, 20 right (52.6%) and 18 left (47.4%) ears as shown in Table 1. There was preponderance in female.

We found that mean absolute SVV results showed significant difference at 24 hours postoperative period. There were no differences in other periods as Table 2.

Table 1. Demographic data

Variables	Total n = 38
Gender	
Male	14 (36.8)
Female	24 (63.2)
Age (years)	
Mean ± SD	44.00±11.31
Range	26 to 66
Side	
Right	20 (52.6)
Left	18 (47.4)

Gender and side were in number (%)

Table 2. Preoperative and postoperative mean absolute SVV results

	Number	Absolute SVV (°) mean ± SD	*p*-value
Preoperative	38	0.75±0.55	<0.01*
Postoperative 24 hours	38	1.53±1.48	
Preoperative	31	0.78±0.54	0.90
Postoperative 1 month	31	0.77±0.64	
Preoperative	22	0.90±0.55	0.25
Postoperative 2 months	22	0.65±0.70	

SVV = subjective visual vertical
* Significant difference

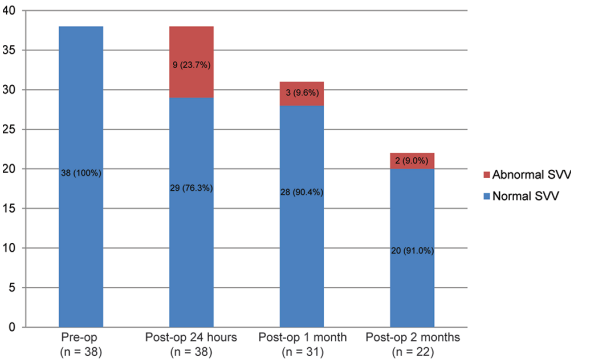

Fig. 5 Number of abnormal SVV patients.

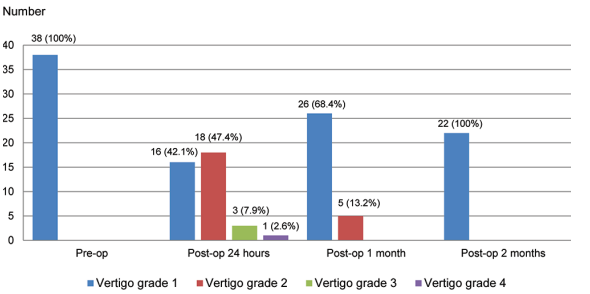

Fig. 6 Vertigo grading results.

At 24-hour, nine out of 38 patients (23.7%) showed abnormal SVV testing. At 1-month and 2-month period, there were three out of 31 patients (9.6%) and two out of 22 patients (9.0%) consecutively (Fig. 5).

However, in vertigo grading perspective, patients had severe vertigo in four out of 38 patients (10.5%) at 24-hour period and no complaint of vertigo at 2-month period (Fig. 6).

There was no correlation between SVV and vertigo grading in the post-stapedectomy patients in the present study (Table 3).

For hearing gain, patients reach satisfied hearing gain in 25 out of 26 patients (96.1%). Patients got excellent hearing in 22 out of 26 patients (84.6%) as shown in Table 4.

Discussion

Generally, otosclerotic patients can expect satisfied hearing results in 70 to 98%[8-10]. At present, there has been no ideal gold standard prosthesis for otosclerotic surgery. In consideration of hearing gain, any new inventory stapes prosthesis has no advantage in hearing gain result than others.

In 1968, idea of polyethylene strut was devised by Dr. Frederick R Guildford[11]. He started

Table 3. Correlation between SVV and vertigo grading

	Bivariate correlation of SVV and vertigo grading	
	Spearman rank correlation coefficient	*p*-value
Postoperative 24 hours	0.09	0.59
Postoperative 1 month	0.25	0.18

Table 4. Hearing results

Residual air-bone gap	Number (%)
Success (≤10 dB)	22 (84.6)
Satisfied (>10 to ≤20 dB)	3 (11.5)
Unsuccessful (>20 dB)	1 (3.9)
Total	26 (100)

with two sizes of PEs then adapted to PE and Teflon. The benefits of this prosthesis are easy-made, cheap, no tendency for incus necrosis, and adjustable length to fit the distance between lenticular process and oval window. In the present study, there were good results (air-bone gap less than 10 dB) about 84.6%, and overall reach satisfied results (air-bone less than 20 dB) about 96.1%. Hearing gain in this study showed the equal standard effectiveness of this tailored-made prosthesis.

Improve hearing gain without complications is the ideal outcome in otosclerotic correction surgery. Nevertheless, the vestibular symptoms are likely to be an inevitable symptom. In general, postoperative vestibular symptoms occur in 27 to 82%[5,6,12]. In our study patients felt dizzy 57.9% during perioperative period; however, dizziness that affect normal activities occurred only 10.5% within 24 hours post operation. Later on, in 1-month period the number of dizzy patients decreased to 16.1% and did not affect their normal activities. Finally, at the 2-month period no patient had complaint about dizziness. There was no difference in dizziness symptom in the present study comparing to other studies (Table 5).

Vestibular symptoms occur in post-stapedectomy, which may lead to permanent otolith dysfunction especially in total stapedectomy. In the present study, we use absolute SVV[13] to determine patients' otolith function at perioperative period, as we knew that SVV could recover when time went by. The results of SVV within 24 hours after surgery came up as our expectations. Total stapedectomy caused 23.7% of abnormal SVV. Nevertheless, patients had clinical problems in only 10.5%. In comparison of stapedotomy, Böhmer and Mast[7] study SVV in 52 stapedotomies. They reported 17% that showed abnormal SVV at first day after operation.

Conclusion

We found the evidences of otolith organs injury after total stapedectomy with tailored-made polyethylene strut by SVV. Nevertheless, these did not cause significant clinical symptoms. In addition, symptomatic patients can recover quickly with good result in hearing gain after surgery.

What is already known on this topic?

Conductive hearing loss from otosclerosis can be corrected either by stapedotomy or total stapedectomy. Both have chance to injure the otolithic organs from the close anatomy between otolithic organs and stapes footplate. Stapedotomy with commercial prosthesis is more popular operation than total stapedectomy.

There are many evidences that SVV test can determine abnormal otolithic organ function in early phase. Abnormal SVV can be found in early post stapedotomy around 20% from many studies.

What this study adds?

Our total stapedectomy patients had abnormal SVV test 23.7% at 24 hours postoperative period. From our knowledge, this is the first study about relation between total stapedectomy and SVV test. The result

Table 5. Vertigo after surgery in each study

	Vertigo by test within 1 week (%)	Significant vertigo symptom postoperative (%)	Vertigo by test in 1 month (%)	Significant vertigo symptom in 1 month (%)	Mean PTA gain (dB)
Hirvonen, et al.[5] (video-oculography)	45.0	45.0	N.A.	N.A.	18
Ozmen, et al.[6] (posturography)	100	48.5	0	0	21
Kujala, et al.[12] (video-oculography)	15.0	27.0	11.0	3.0	22
The present study	23.7	10.5	9.6	0	32

PTA = pure tone average; N.A. = no data

of our study in early postoperative period is quite similar to the result of stapedotomy.

Total stapedectomy with cheap tailored-made polyethylene strut is still be the choice for treatment of otosclerotic patients.

Acknowledgement

Our tailored-made polyethylene strut was introduced by Assistant Professor Prasit Srisomboon more than 30 years ago. He modified this kind of prosthesis from the original one of Dr. Frederick R Guildford's prosthesis. At present, he still operates total stapedectomy with his prosthesis.

Potential conflicts of interest

None.

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การตรวจค่าเบี่ยงเบนในการมองภาพแนวตั้งก่อนและหลังผ่าตัดเอากระดูกโกลนออกทั้งหมด

นิธิตา สัตตรัตน์ไพจิตร, ศิริพร ลิมป์วิริยะกุล, กัญญ์ทอง ทองใหญ่, สมุทร จงวิศาล, ศรัญ ประกายรุ้งทอง

วัตถุประสงค์: *เพื่อเปรียบเทียบผลตรวจ subjective visual vertical test ก่อนและหลังรับการผ่าตัดแก้ไขภาวะกระดูกงอกหูชั้นกลางด้วยการนำกระดูกโกลนออกทั้งหมด และใส่กระดูกหูเทียมแบบประดิษฐ์เอง*

วัสดุและวิธีการ: *ผู้ป่วยภาวะกระดูกงอกหูชั้นกลาง 38 หู ที่เข้ารับการผ่าตัดในโรงพยาบาลศิริราช ตั้งแต่ วันที่ 1 พฤศจิกายน พ.ศ. 2556 ถึง 31 ธันวาคม พ.ศ. 2557*

ผลการศึกษา: *มีผู้ป่วย 9 จาก 38 ราย ให้ผลตรวจ subjective visual vertical test ผิดปกติ ในช่วง 24 ชั่วโมงหลังผ่าตัด คิดเป็น 23.7% และลดลงเป็น 9.6% ในช่วง 1 เดือนหลังผ่าตัดและ 9% ที่ช่วง 2 เดือนหลังผ่าตัด*

สรุป: *การผ่าตัดเอากระดูกโกลนออกทั้งหมดมีโอกาสเกิดการบาดเจ็บต่ออวัยวะการทรงตัวได้ อย่างไรก็ตาม ไม่มีผลทำให้มาตรฐานการใช้ชีวิตของผู้ป่วยแย่ลง*