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Original Article

Impact of carotid stenting in dizzy patients with carotid stenosis

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Abstract

Background: Little is known about the impact of severe carotid stenosis on health-related quality of life (HRQoL). The aim of this study was to assess the effects of carotid stenting (CAS) on HRQoL in dizzy patients with carotid stenosis.
Methods: Patients with symptomatic (≥60%) or asymptomatic (≥80%) severe carotid stenosis and who complained of dizziness and received CAS were recruited. Two HRQoL questionnaires—a generic survey, the 36-item Short-Form Health Survey and a disease-specific instrument, the Dizziness Handicap Inventory—served as outcome measures. Patients were followed 1 week prior to CAS and 6 months postprocedurally.
Results: CAS was performed in 178 consecutive patients, 61 of whom complained of dizziness. Forty-one patients (67.2%, 34 male; mean age, 73.3 ± 10.5 years; range, 47–87 years) completed the study. Twenty asymptomatic volunteers (17 male; mean age, 70.3 ± 9.3 years; range, 54–84 years) served as normal controls. Compared to controls, patients tallied lower scores in the overall total and three subscales (physical, functional, and emotional) of the Dizziness Handicap Inventory ($p < 0.01$). Similar findings were noted in seven out of eight domains of the 36-item Short-Form Health Survey score. After 6 months, CAS resulted in significantly improved HRQoL (role physical, bodily pain, general health, social function, and role emotional) in these patients.
Conclusion: CAS resulted in improved HRQoL in patients with severe carotid stenosis who experienced dizziness.

Keywords: carotid stenosis; dizziness; quality of life; stenting

1. Introduction

Dizziness is a common complaint in the general population.[1] Of the various etiologies, vestibular or psychiatric causes account for more than 70% of dizziness.[2] Cardiovascular and cerebrovascular diseases are common nonvestibular causes of dizziness, especially in the elderly.[3] In addition to the well-known cause of vertebrobasilar disorders, carotid stenosis may also play a role in the genesis of dizziness. Weinberger et al[4] found that out of 101 patients complaining of nonspecific dizziness, 21 had hemodynamically significant carotid stenosis. Similar results have been reported by other authors.[5,6] This might imply that the symptoms of dizziness may result from decreased cerebral perfusion due to carotid artery occlusive disease in some patients complaining of dizziness. Carotid revascularization, such as through carotid stenting (CAS), has emerged as a potential therapeutic alternative in patients with severe carotid stenosis for the prevention of recurrent ischemic events.[7,8] However, the role of such revascularization in patients with dizziness is still unclear. In addition, little is known about the impact of CAS on quality of life.

Conflicts of interest: The authors declare that there are no conflicts of interest related to the subject matter or materials discussed in this article.

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Dizziness can be extremely troublesome. It can lead to considerable impairment in daily functioning and jeopardize personal, professional, social, and leisure activities. Accordingly, in order to manage these patients adequately, it is important to assess the impact of dizziness on everyday life.

Therefore, the objectives of the present research were: (1) to assess dizziness-related impairment upon quality of life in patients with severe carotid stenosis; and (2) to see if CAS can result in improved health-related quality of life (HRQoL) in these patients.

2. Methods

2.1. Study population

This study was conducted in a tertiary referral hospital in northern Taipei, Taiwan, R.O.C. Patients with a chief complaint of nonspecific dizziness, e.g., feelings of giddiness, imbalance, light-headedness, a sensation of impending faint, for >1 month and/or minor stroke using the modified Rankin scale ≤2 prior to entry or transient ischemic attack (TIA) referred to the hospital's neurovascular laboratory for screening of carotid stenosis were invited to participate in the study. Patients were deemed to be suitable candidates if they met the following criteria: (1) evidence of unilateral extracranial carotid stenosis ≥60%, if they were symptomatic (history of old minor stroke/TIA in addition to dizziness complaints) or ≥ 80% if they were considered asymptomatic (complained of dizziness alone); and (2) complete 6-month follow-up data were available. Patients were excluded if they had: (1) ≥ 50% stenosis or occlusion of contralateral carotid artery or the vertebra-basilar arteries; (2) ≥ 50% stenosis of the intracranial arteries; (3) hemorrhagic or brainstem strokes; (4) history of overt causes of dizziness or vertigo, such as peripheral vestibular dysfunction; (5) other causes of dizziness or unsteadiness such as cardiovascular medications, central or peripheral neurological disorders, cardiopulmonary, or musculoskeletal or psychiatric diseases; (6) previous history of carotid endarterectomy, angioplasty, or stenting; or (7) carotid dissection or radiation angiopathy. In addition, 20 sex- and age-matched asymptomatic individuals of our general neurology outpatient department free of dizziness and carotid stenosis (17 male; mean age, 70.3 ± 9.3 years; range, 54–84 years) served as normal controls. The study hospital's Institutional Review Board approved the study protocol and each participant provided signed informed consent prior to entering the study.

2.2. Diagnosis of carotid stenosis

The investigations of the extracranial neck vessels were performed by an experienced technician using a two-dimensional color Duplex ultrasound scanner (Acuson 128XP; Acuson, Mountain View, CA, USA). The diagnosis of carotid stenosis was first made by duplex ultrasound with a 7.5-MHz pulsed-wave transducer for extracranial examination modified from the study by Grant et al.[9] The degree of carotid stenosis was ultimately confirmed by diagnostic cerebral angiography during CAS based on the North American Symptomatic Carotid Endarterectomy Trial (NASCET) criteria.[10]

2.3. Protocol for CAS

Premedication for CAS included a combination of aspirin (100 mg/day) and clopidogrel (75 mg/day), started at least 3 days prior to CAS. During the procedure, a transfemoral arterial approach was used to obtain a complete angiogram of the supra-aortic arteries and their branches, including bilateral carotid, bilateral vertebral, and bilateral subclavian arteries. A 6F guiding sheath (Shuttle sheath, Cook Co. Bloomington, IN, USA) was placed into the proximal common carotid artery. Through the guiding sheath, a 0.014F marker wire (Boston Scientific Corporation, Natick, MA, USA) was advanced to the carotid artery. A magnified diagnostic angiogram was performed and the diameter and length of the stenosis was measured by reference to the marker wire. A cerebral protection device (FilterWire Ex or Ez; Boston Scientific Corporation) was carefully navigated through the stenotic lesion and placed in the distal cervical internal carotid artery. Predilatation of the carotid atherosclerotic lesion with a coronary balloon (3–4 mm in diameter) was done in cases of >90% stenosis. A self-expandable stent (Wallstent; Boston Scientific Corporation; or Precise stent; Cordis Co. Bridgewater, NJ, USA) was selected according to the dimensions of the diseased carotid artery. Postdilatation with a balloon of 5–6 mm in diameter was done in all cases. A control angiogram was performed for the carotid artery and its intracranial branches to confirm that the residual stenosis of the treated atherosclerotic lesion was <30% and without intracranial vascular complication. Postprocedurally, all patients received the combination therapy of aspirin (100 mg/day) and clopidogrel (75 mg/day) for 3 months, and then aspirin monotherapy indefinitely.

Our primary outcome was the impact of dizziness on quality of life. Therefore, two HRQoL questionnaires, the 36-item Short-Form Health Survey (SF-36) and the Dizziness Handicap Inventory (DHI), were used as outcome measures in the current study.

2.4. Medical outcome study SF-36

The SF-36, originally developed for the Rand Corporation's Health Insurance Experiment,[11,12] is a 36-item, self-administered generic questionnaire for the measurement of HRQoL over the previous 4 weeks. The SF-36 has eight domains that reflect physical health, mental health, and the impact of health on daily functioning: physical functioning (PF, 10 items); role limitation due to physical problems (RP, 4 items); bodily pain (BP, 2 items); vitality (VT, 4 items); general health perceptions (GH, 5 items); social functioning (SF, 2 items); role limitation due to emotional problems (RE, 4 items); and mental health (MH, 5 items).

After summing up the Likert-scale items in the SF-36, each scale was then standardized so that it ranged from 0 to 100, with higher scores indicating better health status.[13] The

translation of the Chinese version of the SF-36 was developed using a standard methodology that was followed by the International Quality of Life Assessment Project.[14] The Cronbach α coefficient values of internal consistency for the Chinese Version of SF-36 were all above the criteria of 0.7 (range, 0.72–0.90), as demonstrated in a previous study.[14]

2.5. DHI

The DHI, a disease-specific questionnaire, was developed to measure self-perceived disability in dizzy patients.[15] It is a 25-item, self-rated questionnaire subdivided into three subscales: nine items related to emotional well-being; nine items related to functional activities; and seven items related to physical activities. Each question is answered "yes", "sometimes", or "no" with scores of 4, 2, and 0 respectively, indicating how problematic or difficult each item is for the patient due to dizziness. A total possible DHI score ranges from 0 (indicating no disability) to 100 (indicating marked handicap). It has high internal consistency and good test–retest reliability.[15,16] The production of the Chinese version of the DHI also followed the standard forward, backward, and pretest steps for instrument translation.[17] The Cronbach α coefficient values for the Chinese version of DHI were all above the criteria of 0.7 (range, 0.79–0.87) with good test–retest reliability.[18]

Both questionnaires were taken 1 week prior to CAS as the baseline value, and follow-up studies were done at 1 month and 6 months postprocedurally.

2.6. Statistical analysis

SPSS version 16.0 for Windows (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Descriptive data are presented as mean ± standard deviation and range for all variables. The eight SF-36 dimensions were scored from 0 (worst possible health status) to 100 (best possible health status), by coding, summating, and transforming its relevant item scores according to the SF-36 manual.[13] The scores of total scale and subscales (physical, functional, and emotional) of each participant were calculated by summing up each score on the DHI.[15] The Wilcoxon rank-sum test was used for between group analyses. Because the DHI and SF-36 scores were not normally distributed, nonparametric comparisons among the three times test were done with the Friedman test. For *post hoc* analyses, we used the Wilcoxon rank-sum test with Bonferroni correction. A p value ≤ 0.05 was considered to be the threshold of statistical significance for those without *post hoc* analysis. For those needing *post hoc* analysis with Bonferroni correction, $p \leq 0.025$ (0.05/2) was considered to be the threshold of statistical significance.

3. Results

From January 2009 to December 2011, CAS was performed in a total of 178 patients with severe internal carotid artery stenosis, 61 of whom complained of dizziness. Of these 61 patients, 20 were dropped because of loss of follow-up (17 cases) or periprocedural complications (3 cases). Thus, 41 (67.2%, 34 male, mean age: 73.3 ± 10.5 years, range: 47–87 years) who fulfilled both the inclusion and exclusion criteria were left to form the basis of this study. No peri- or post-procedural complications, such as embolic stroke, hyperperfusion, or intracranial hemorrhage, developed during the follow-up period in these 41 patients.

By definition, dizziness was present in all patients. Twelve (29.3%) patients had previous minor stroke or TIA, 33 (80.5%) patients had hypertension, and diabetes and hyperlipidemia occurred in six (14.5%) patients. Table 1 shows the demographic data of all patients.

Compared with normal controls, patients with carotid stenosis had worse baseline general HRQoL as evaluated by the SF-36: PF, 54.9 ± 24.8 vs. 80.5 ± 15.5; RP, 20.1 ± 36.3 vs. 61.3 ± 40.1; BP, 76.4 ± 15.6 vs. 76.6 ± 17.1; GH, 55.3 ± 19.6 vs. 69.5 ± 18.1; VT, 48.4 ± 18.3 vs. 65.8 ± 15.2; SF, 56.7 ± 18.4 vs. 80.6 ± 16.5; RE, 27.6 ± 42.8 vs. 66.7 ± 34.5; and MH, 62.3 ± 18.4 vs. 71.6 ± 15.4. CAS resulted in a significant improvement in the general health status of these patients. There was significant improvement in social function 1 month after CAS. After 6 months, there were significant improvements in the RP, BP, GH, SF, and RE domains. Fig. 1 depicts changes of the SF-36 subscales 1 month and 6 months after CAS.

The mean baseline total DHI score was 17.5 ± 12.2, which was also significantly higher than that of the normal controls (1.8 ± 2.1, $p < 0.001$). Similarly, the DHI also improved significantly 6 months after CAS (11.7 ± 11.7, $p = 0.0027$ vs. baseline value). The mean baseline physical and functional subscores were 5.0 ± 3.6 and 7.8 ± 5.1 respectively, which improved significantly to 3.6 ± 3.4 and 5.6 ± 5.5 (both $p < 0.025$ vs. baseline values) 1 month after CAS. These improved further to 3.4 ± 3.4 and 4.9 ± 5.0 (both $p < 0.01$ vs. baseline values) 6 months after CAS. There were no significant interval changes for the emotional subscore. The results of the total DHI score and its subscores are shown in Fig. 2.

Table 1
Demographic data of patients ($n = 41$) and normal controls ($n = 20$).

	Patients		Controls		p
	n	%	n	%	
Age (y), mean ± SD	73.3 ± 10.5		70.3 ± 9.3		0.729*
Sex (male)	34	83	17	85	0.837**
Hypertension	33	80.5	17	85	0.667**
DM	6	14.6	4	20	0.595**
Stroke or TIA	12	29.3	6	30	0.935**
CAD	7	17.1	4	20	0.780**
Hyperlipidemia	6	14.6	4	20	0.595**
Smoke	12	29.3	7	35	0.650**
Stenosis					
L	15	36.6			
R	26	63.4			
Degree of stenosis					
Mean ± SD	77.7 ± 10.8				
Range	60–95%				

*Student t test; **Chi square test.
CAD = coronary artery disease; DM = diabetes mellitus; L = left; R = right; SD = standard deviation; TIA = transient ischemic attack.

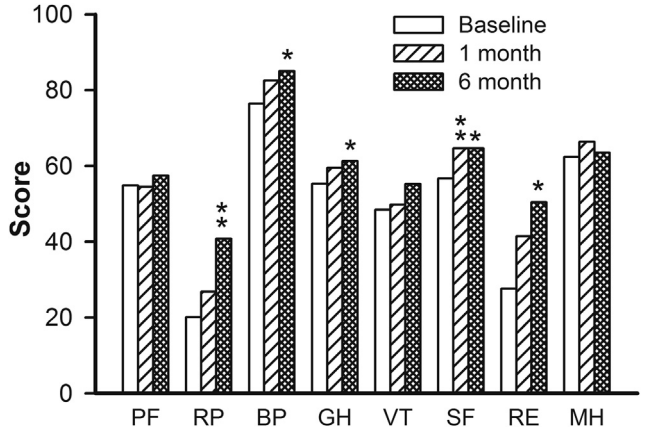

Fig. 1. Generic health status during follow-up. The trend of the 36-item Short-Form Health Survey scores from baseline to 6 months after carotid stenting of the 41 patients is shown in Fig. 1. Higher scores indicate better quality of life. There are significant differences in 5 of 8 subscales during the 6-month follow-up. *$p < 0.025$. **$p < 0.01$, compared with baseline values. BP = bodily pain; GH = general health perception; MH = mental health perception; PF = physical functioning; RE = role limitation due to emotional problems; RP = role limitation due to physical problems; SF = social functioning; VT = vitality.

In order to clarify the effects of degree of carotid stenosis and the history of previous stroke or TIA on the HRQoL in these patients, *post hoc* analysis was used to examine the influence of these factors. It showed that patients with more severe carotid stenosis (≥80%) or prior history of minor stroke/TIA prior to entry benefited most from CAS (Tables 2 and 3).

4. Discussion

In this study, we demonstrated that nonspecific dizziness was present in a number of patients with hemodynamically significant carotid stenosis. Furthermore, it had some negative impact on HRQoL in these patients, which can be improved by CAS.

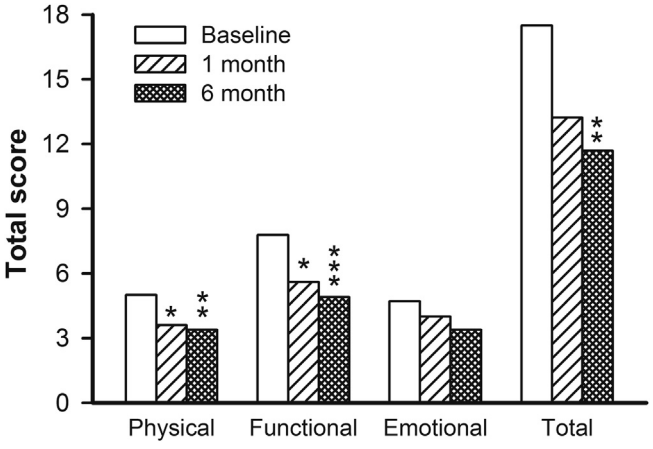

Fig. 2. Disease-specific health status during follow-up. The trend of the Dizziness Handicap Inventory scores from baseline to 6 months of the 41 patients after carotid stenting. Lower scores indicate better quality of life. There are significant differences in total as well as physical and functional subscales of the Dizziness Handicap Inventory during the 6-month follow-up. *$p < 0.025$, **$p < 0.01$, ***$p < 0.001$, compared with baseline values.

Dizziness is a prevalent and ubiquitous symptom in the general population.[2] Vestibular system diseases account for over half of the cases.[2] Cardiovascular (including cerebrovascular) disorders are important nonvestibular causes of dizziness, especially those with a feeling of fainting or lightheadedness.[3] Severe carotid stenosis, which causes disturbance of blood flow to the cranium, was present in 14–21% of patients with nonspecific dizziness.[4–6] Our hospital is a tertiary referral center, which could partially explain the seemingly higher proportion (one-third, 61/178) of patients experiencing dizziness in our series.

Despite the high prevalence, patients with dizziness frequently have difficulty describing and quantifying their perception of dizziness.[19] The self-rated questionnaire is a useful tool to assess the perceived disability and treatment outcome of dizziness. Two types of questionnaires have been widely used for this purpose: a general health status questionnaire and a disease-specific questionnaire. The SF-36 is a frequently used generic measurement of health status. This multidimensional scale assesses the impact of disease on wellbeing and functional status. DHI is a commonly used disease-specific HRQoL instrument in patients with dizziness. It has been used to assess the level of impairment in patients experiencing dizziness[20] as well as efficacy of the treatment outcome.[21] Previously, we have found a poor HRQoL, as measured with the SF-36, in elderly Taiwanese patients experiencing dizziness.[22] In the present study, patients with severe carotid stenosis who experienced dizziness had significantly lower scores than age- and sex-matched control individuals in all eight domains of the SF-36 parameters, except for BP, as well as the total and three subscales of the DHI prior to therapy. These results further confirmed the negative impact of dizziness upon HRQoL.

Scores for our patients ranged from 33% to 88% of the control values for 7 out of the 8 subscales of the SF-36, with the lowest scores occurring in the RP (33%) and RE (41%) domains. Similar findings were observed in two previous reports in which the SF-36 was used to measure disability in patients with dizziness.[23,24] The severe limitations seen in patients' physical and emotional well-being strongly underscores the disabling nature of dizziness.

The high total DHI scale indicates that patients with carotid stenosis are negatively affected by their dizzy symptom. Of the three subscales of DHI, patients more frequently reported functional and physical impairment than emotional distress. These results are consistent with several other studies.[20,24–26] Apparently, such patients may have suffered significant role limitations due to physical problems and social function or vitality.

Recently, CAS has emerged as an alternative therapeutic option in patients with significant carotid stenosis.[7,8] However, little is known about the impact of CAS on HRQoL. Our study shows that CAS resulted in significant improvement in HRQoL in a group of patients with both carotid stenosis and dizziness. Previously, there were only one nonrandomized and two large-scale clinical trials evaluated quality of life after CAS versus carotid endarterectomy.[27–29] Substudies from SAPPHIRE (Stenting

Table 2
Baseline values and changes in health status scores 1 month and 6 months after carotid stenting in patients with <80% carotid stenosis versus patients with ≥80% carotid stenosis.

	<80% stenosis ($n = 20$)			≥80% stenosis ($n = 21$)		
	Baseline	1 mo	6 mo	Baseline	1 mo	6 mo
P	5.9 ± 3.5	3.7 ± 3.7	4.1 ± 3.6	4.2 ± 3.6	3.5 ± 3.3	2.8 ± 3.0
E	5.3 ± 4.1	3.5 ± 4.3	4.3 ± 5.0	4.2 ± 4.5	4.5 ± 5.4	2.5 ± 3.2
F	8.8 ± 4.4	5.4 ± 5.7	5.5 ± 5.5*	6.9 ± 5.6	5.8 ± 5.3	4.3 ± 4.7*
T	19.9 ± 11.1	12.6 ± 12.8	13.9 ± 12.8	15.2 ± 13.0	13.8 ± 13.3	9.6 ± 10.5*
PF	57.5 ± 29.8	58.5 ± 27.0	55.3 ± 29.4	52.4 ± 19.3	50.7 ± 25.6	59.5 ± 24.1
RP	28.8 ± 39.9	37.5 ± 42.5	47.5 ± 45.1	11.9 ± 31.2	16.7 ± 31.9	34.5 ± 42.2
BP	78.9 ± 15.1	79.9 ± 18.6	78.2 ± 18.4	73.9 ± 16.1	85.0 ± 20.7	91.2 ± 10.6**
GH	52.6 ± 19.7	63.2 ± 25.7	59.3 ± 28.1	57.9 ± 19.7	56.1 ± 21.5	63.2 ± 18.4
VT	45.8 ± 19.3	51.8 ± 22.8	54.8 ± 23.0	50.9 ± 17.4	47.96 ± 20.5	55.7 ± 20.5
SF	56.3 ± 18.4	59.9 ± 15.4	60.0 ± 25.2	57.1 ± 18.8	69.1 ± 15.1*	69.1 ± 14.6*
RE	35.0 ± 45.2	51.7 ± 46.5	51.7 ± 50.1	20.6 ± 40.1	31.8 ± 40.1	49.2 ± 47.9
MH	60.0 ± 17.8	67.0 ± 21.7	61.2 ± 21.8	64.6 ± 19.0	65.7 ± 17.3	65.7 ± 19.7

*$p < 0.01$, **$p < 0.001$, compared to baseline values.
BP = bodily pain; E = emotional subscale of the Dizziness Handicap Inventory (DHI); F = functional subscale of the DHI; GH = general health perception; MH = mental health perception; P = physical subscale of the DHI; PF = physical functioning; RE = role limitation due to emotional problems; RP = role limitation due to physical problems; SF = social functioning; T = total score of the DHI; VT = vitality.

and Angioplasty with Protection in Patients at High Risk for Endarterectomy) and CREST (Carotid Revascularization Endarterectomy vs. Stenting Trial) trials found that carotid revascularization, particularly CAS, improved HRQoL as measured by both generic (SF-36) and disease-specific instruments postprocedurally.[28,29] Both studies found that, compared to carotid endarterectomy, CAS resulted in a significant improvement in role physical function at 2 weeks and 1 month postprocedurally. We also found that CAS resulted in improvement in general HRQoL, especially the role limitations in physical and emotional domains 1 month after the operation, which persisted for 6 months postprocedurally. Furthermore, in the present study, the disease-specific questionnaire, the DHI for dizziness-related handicap, also showed parallel improvement after CAS. Likewise, there were greater improvements in the physical and functional subscales. Data from a subgroup analysis of the CREST trial revealed that patients who suffered from a periprocedural stroke had the worst health status.[29] No major periprocedural events occurred in our series. However, we found that patients with a more severe degree of carotid stenosis and prior stroke events benefited most from CAS. The fact that patients with ≥80% stenosis improved most could imply that the more improved the perfusion status, the greater improvement seen in dizziness. Further studies are needed to clarify the impact of cerebral perfusion and previous stroke on quality of life.

The strengths of our study are that both generic and disease-specific instruments were used in our patients, allowing comparison with other trials and the recruitment of control individuals for comparison. Nonetheless, our study did have some limitations. First, vestibular function evaluation, e.g., the caloric test, was not performed in our patients to exclude the possibility of inner ear problems. However, patients with the complaint of vertigo or prior history of vestibular disorders were excluded from the present study to minimize the impact

Table 3
Baseline values and changes in health status scores 1 month and 6 months after carotid stenting in patients with no prior history of stroke versus patients with stroke/TIA.

	No stroke ($n = 29$)			Stroke or TIA ($n = 12$)		
	Baseline	1 mo	6 mo	Baseline	1 mo	6 mo
P	4.9 ± 3.5	3.6 ± 3.5	3.9 ± 3.6	5.2 ± 3.8	3.7 ± 3.4	2.1 ± 2.4
E	4.5 ± 4.0	3.9 ± 4.8	3.8 ± 4.6	5.3 ± 5.0	4.3 ± 5.1	2.4 ± 3.1
F	7.7 ± 4.9	5.3 ± 5.2*	5.1 ± 4.9*	8.1 ± 5.8	6.3 ± 6.3	4.3 ± 5.4*
T	17.0 ± 11.7	12.8 ± 12.6	12.9 ± 12.2	18.6 ± 13.8	14.3 ± 14.3	8.8 ± 10.4*
PF	58.3 ± 23.8	58.1 ± 24.2	59.3 ± 25.3	46.7 ± 26.3	45.8 ± 29.8	52.9 ± 30.1
RP	26.7 ± 41.2	31.0 ± 38.2	42.2 ± 43.9	24.2 ± 9.7	16.7 ± 38.9	37.5 ± 44.6
BP	77.3 ± 16.4	85.3 ± 17.3	82.4 ± 16.6	74.3 ± 14.0	75.8 ± 23.8	91.1 ± 13.4*
GH	57.2 ± 20.7	62.1 ± 22.7	60.8 ± 24.9	50.1 ± 16.2	53.4 ± 25.6	62.5 ± 20.4
VT	50.3 ± 18.4	54.1 ± 19.0	56.7 ± 21.4	43.8 ± 17.9	39.2 ± 24.1	51.7 ± 22.2
SF	59.1 ± 18.3	63.4 ± 15.6	64.7 ± 20.6	51.0 ± 18.0	67.7 ± 16.4*	64.6 ± 21.9
RE	35.6 ± 45.4	40.2 ± 43.9	47.1 ± 49.2	38.3 ± 28.9	44.4 ± 45.7	58.3 ± 47.4*
MH	62.6 ± 18.5	70.1 ± 17.4	63.2 ± 22.6	61.7 ± 18.9	57.3 ± 21.6	64.3 ± 15.6

*$p < 0.01$, compared with baseline values.
BP = bodily pain; E = emotional subscale of the Dizziness Handicap Inventory (DHI); F = functional subscale of the DHI; GH = general health perception; MH = mental health perception; P = physical subscale of the DHI; PF = physical functioning; RE = role limitation due to emotional problems; RP = role limitation due to physical problems; SF = social functioning; T = total score of the DHI; VT = vitality.

of inner ear diseases. Second, as stated above, other perfusion parameters, such as cerebral blood flow, were not measured in our study; it is premature to conclude the role of perfusion change in dizzy patients. Third, because the sample came from a veteran's hospital, male patients predominated. Fourth, dizzy patients with symptomatic or asymptomatic carotid stenosis who did not receive CAS were not recruited as controls because almost all of them had received CAS. Fifth, about one-third of the study participants were lost through follow-up in the current study, which might affect the final results. However, there were no significant differences in demographic and available HRQoL data (data not shown), so it is less likely to affect the final results. Finally, given the relatively small sample size and intermediate follow-up period, our study might have had insufficient detection of minor treatment effects at later periods of time.

In conclusion, our findings elucidate the role of hemodynamically significant carotid stenosis in patients with dizziness. CAS results in improvement of HRQoL in these patients. Large-scale studies are needed to test the hypothesis that screening for carotid artery disease should be part of the protocol to evaluate patients with dizziness.

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