

Clinical Article

The Quality of Life of Patients with Good Outcomes after Anterior Circulation Aneurysm Surgery Assessed by the World Health Organization Quality of Life Instrument-Korean Version

Kyung-Sool Jang, M.D., Ph.D., Young-Min Han, M.D., Ph.D., Dong-Kyu Jang, M.D., Sang-Kyu Park, M.D., Young Sup Park, M.D., Ph.D.

Department of Neurosurgery, Incheon St. Mary's Hospital, The Catholic University of Korea College of Medicine, Incheon, Korea

Objective : Even in the patients with neurologically good outcome after intracranial aneurysm surgery, their perception of health is an important outcome issue. This study aimed to investigate the quality of life (QOL) and its predictors of patients who had a good outcome following anterior circulation aneurysm surgery as using the World Health Organization Quality of Life instrument-Korean version.

Methods : We treated 280 patients with 290 intracranial aneurysms for 2 years. This questionnaire was taken and validated by 99 patients whose Glasgow Outcome Scale score was 4 and more and Global deterioration scale 3 and less at 6 months after the operation, and 85 normal persons. Each domain and facet was compared between the two groups, and a subgroup analysis was performed on the QOL values and hospital expenses of the aneurysm patients according to the type of craniotomy, approach, bleeding of the aneurysm and brain injury.

Results : Aneurysm patients showed a lower quality of life compared with control patients in level of independence, psychological, environmental, and spiritual domains. In the environmental domain, there were significant intergroup differences according to the type of craniotomy and the surgical approach used on the patients ($p < 0.05$). The hospital charges were also significantly different according to the type of craniotomy ($p < 0.05$).

Conclusion : Despite good neurological status, patients surgically treated for anterior circulation aneurysm have a low quality of life. The craniotomy size may affect the QOL of patients who underwent an anterior circulation aneurysm surgery and exhibited a good outcome.

Key Words : Anterior circulation aneurysm · Quality of life · Craniotomy size · Surgical approach.

INTRODUCTION

Several studies have investigated the quality of life (QOL) after treatment for patients with intracranial aneurysms^{4,17,21}. Many factors including the aneurysm origin, age and sex of the patient, neurological condition upon admission, extension of the hemorrhage, physical handicap, the presence of depression, cognitive impairment, the Glasgow Outcome Scale (GOS) and sleep problems were found to be associated with the QOL of patients who underwent cerebral aneurysm surgery^{1,5,6,7,10,16,20}.

Recently, in QOL assessments, there has been growing interest in the individual's subjective feelings on life aspects. With regards to the outcome assessment of the patients treated with intracranial aneurysms, a single graded scale such as the GOS,

modified Rankin Scale, Barthel Index and the National Institutes of Health Stroke Score may not necessarily address all of the aspects of recovery, especially cognition and the patient's perception of health⁹. Therefore, although the patients may have good neurological outcomes and possess cognitive function after intracranial aneurysm surgery, they may still have the potential to experience a poor QOL. In addition, the treatment modalities of the intracranial aneurysms, especially endovascular procedures or minimally invasive operations, have evolved considerably in recent years. The rates of mortality and morbidity related to the surgical or endovascular treatment of ruptured or unruptured intracranial aneurysms have also decreased substantially^{3,8,13}. However, the QOL of aneurysm patients treated with minimally invasive methods has not yet been evaluated.

• Received : April 28, 2012 • Revised : June 27, 2012 • Accepted : September 17, 2012

• Address for reprints : Dong-Kyu Jang, M.D.

Department of Neurosurgery, Incheon St. Mary's Hospital, The Catholic University of Korea College of Medicine, 56 Dongsu-ro, Bupyeong-gu, Incheon 403-720, Korea
Tel : +82-32-280-5867, Fax : +82-32-280-5991, E-mail : argus3620@gmail.com

• This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Min et al.¹¹⁾ developed the World Health Organization Quality of Life (WHOQOL) instrument-Korean version, which has 100 detailed items; however, this instrument has not been validated and used to evaluate patients with cerebrovascular diseases but general Korean populations.

This study aimed to investigate the QOL of patients who underwent anterior circulation aneurysm surgery and had a good outcome by validating and using the WHOQOL instrument-Korean version. Moreover, the study also focused on the identification of contributing factors associated with surgical methods in the patient's perception of health.

MATERIALS AND METHODS

Study design and patients

This study was a retrospective case - control study where the participants were recruited from a single center. The source population consisted of aneurysm patients from our institute who underwent surgical treatment between September 2008 to October 2010. Patients who were newly diagnosed or patients who were surgically treated for an anterior circulation aneu-

rysm and showed a good neurological outcome at 6 months after surgery were selected. A good outcome at 6 months was defined as the following : GOS score ≥ 4 and a global deterioration scale (GDS) score ≤ 3 . The exclusion criteria were patients with a poor outcome, patients who exhibited a posterior circulation aneurysm, and patients who were treated with a coil embolization or did not provide their informed consent. Out of a total of 280 patients with 290 intracranial aneurysms, 181 patients were excluded (31 coiling patients, 17 posterior circulation aneurysm patients, 41 patients with GOS less than 3, and 92 patients with GDS greater than 3 or were without informed consent) (Fig. 1). The final number of aneurysm patients included in this study was 99. The total number of control subjects was 85, which included the hospital staff, their family and acquaintances, and the patients' families (the demographic data are described in Table 1). The QOL values and clinical factors associated with QOL such as age, sex, education, marriage status, illness, World Federation of Neurosurgical Societies (WFNS) grade, Hunt and Hess grade, Fisher grade, brain injury, rupture of the aneurysm, craniotomy size, surgical approach and hospital charges were assessed in either the case or control groups (Table 1, 2). This study was approved by the local institutional review board.

Surgical methods and outcome evaluation

During the study period, all of the operations were conducted by one cerebrovascular team, and the surgical approach was determined according to the aneurysm site, dome direction, control of the parental artery, hemorrhage volume and site, brain swelling and the patient's or surgeon's preference. A conventional craniotomy was defined as a standard pterional craniotomy as described by Yasargil and Fox²⁴⁾ or by a bifrontal craniotomy of the distal anterior cerebral artery aneurysm or anterior communicating aneurysm with or without extraventricular drainage. A supraorbital craniotomy was conducted via an eyebrow skin incision as previously described by Perneckzy et al. (Fig. 2A)^{18,19)}. Recently, one study reported a microsurgical experience using supraorbital keyhole operations on anterior circulation aneurysms¹⁵⁾.

However, the supraorbital keyhole operation has several limitations in its effectiveness, particularly with some cases of the middle cerebral artery (MCA) bifurcation aneurysms, where the M1 segment is too long or there is a lateral and

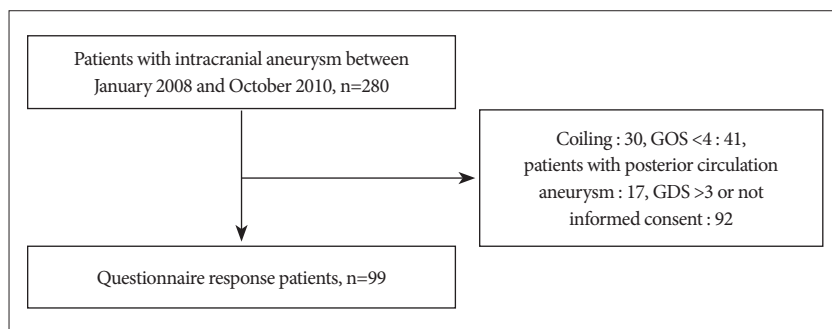


Fig. 1. Schematic diagram of the screening of patients surgically treated with anterior circulation aneurysms and who completed WHOQOL questionnaire. WHOQOL : World Health Organization Quality of Life, GOS : Glasgow Outcome Scale, GDS : global deterioration scale.

Table 1. General characteristics of the case and control subjects

Variables	Case (n=99)	Control (n=85)	p-value
Age (years)	54.8±10.9	51.3±10.8	0.031*
Gender			0.48
Male	29 (29.2)	29 (34.1)	
Female	70 (70.7)	56 (65.9)	
Education			<0.001*
Below high school	84 (84.8)	43 (50.6)	
Above college	15 (15.2)	42 (49.4)	
Marriage status			0.011*
Single or separated	38 (38.4)	18 (21.2)	
Married or living as married	61 (61.6)	67 (78.8)	
Illness			0.009*
Healthy	27 (27.3)	39 (45.9)	
III [†]	72 (72.7)	46 (54.1)	

*t-test or chi-squared test was used, [†]III indicates having chronic health problems such as heart disease, diabetes, sequelae from stroke, chronic arthritis, thyroid disease, chronic liver disease, cancer, neuropsychiatric disorder, sequelae from trauma, operation history, chronic pain and so on

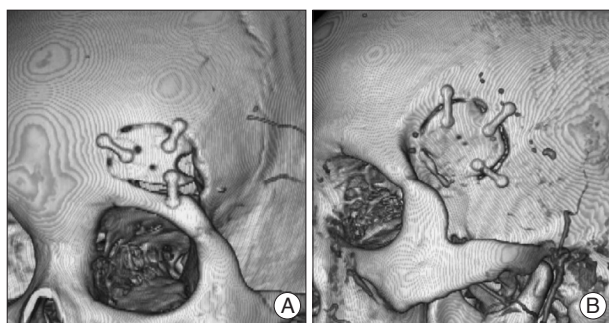


Fig. 2. Representative small craniotomies showing supraorbital (A) and pterional approach (B).

caudal direction of their aneurysm domes, supraclinoid internal carotid artery (ICA) aneurysm, or posterior communicating artery (PCoMA) aneurysm with posteroinferior projection^{2,14}. Nathal and Gomez-Amador¹⁴ previously described a sphenoid ridge keyhole approach for cerebral aneurysms that also has several limitations including the limited opening of the sylvian fissure to increase the tendency towards a more significant brain retraction. We have performed a modified small pterional craniotomy with a similar skin incision as the conventional pterional craniotomy but with a subfascial muscle dissection. A single burr hole was made at the point 3-4 cm posterior from the frontozygomatic point and 1 cm ventral from the superior temporal line of the skull, using a high-speed drill. A dural dissector was used to separate the dura mater from the bone, particularly in elderly patients, to avoid dural tearing during sawing. The margin of the craniotomy forms a superior boundary up to the superior temporal line and inferiorly to the temporal bone. The center of the craniotomy could be moved towards the frontal or temporal lobe depending on the direction of the intradural surgical trajectory towards the target aneurysm (Fig. 2B).

We divided the craniotomy types according to size into conventional craniotomy of which the minimum diameter was greater than 4 cm and small craniotomy, which was characterized by a supraorbital or frontotemporal craniotomy of which the maximum diameter was less than 4 cm (Fig. 2). The surgical methods consisted of two approaches: the supraorbital approach and the pterional/others approach. All of the patients' profiles were assessed by a retrospective chart review, and the patients' neurological outcomes were evaluated at the time that the questionnaire was obtained. The craniotomy size was measured in the postoperative brain using a 3-dimensional multi-detector CT scan. The brain injury, however, was identified only as a low density lesion that was more than 1 cm according to a postoperative CT image taken within two weeks.

Instruments and calculation of scores

QOL was evaluated using the WHOQOL instrument-Korean version, which was previously validated by Min et al.¹¹. This questionnaire measures the patients' general health across six dimensions: 1) physical domain (PHY), 2) psychological domain (PSY), 3) levels of independence (IND), 4) social relation-

Table 2. Clinical summary of the case subjects

Variables	Case (n=99)
WFNS grade	
1	84
2	10
3	1
4	3
5	1
Hunt and Hess grade	
1	58
2	35
3	4
4	2
5	0
Fisher grade	
1	60
2	12
3	20
4	8
Bleeding of aneurysm	
Ruptured	42
Unruptured	57
Location of aneurysm	
MCA	31
ACoMA	30
PCoMA	16
ICA	14
ACA	5
AchoA	3
Treated multiple aneurysms*	16
Type of craniotomy	
Conventional ($\varnothing > 4$ cm)	55
Small ($\varnothing < 4$ cm)	44
Type of approach	
Pterional or others	86
Supraorbital	13
Brain injury [†]	
Yes	21
No	78
Symptomatic vasospasm	5
Hydrocephalus	3
Glasgow outcome scale	
4	9
5	90
Global deterioration scale	
1	84
2	10
3	5

*Multiple aneurysms were identified and were all clipped successfully, [†]Brain injury was defined as a low density of more than 1 cm according to the immediate postoperative brain CT scan. MCA: middle cerebral artery, ACoMA: anterior communicating artery, PCoMA: posterior communicating artery, ICA: internal cerebral artery, ACA: anterior cerebral artery, AchoA: anterior chroidal artery

ship (SOC), 5) environmental domain (ENV), and 6) spiritual domain (SPI). The overall QOL score was the sum of the questions regarding global QOL. Each of the domains consisted of 8-16 questions and addressed 1-4 facets. The facet scores for the WHOQOL were calculated by the mean of all of the items included in each facet according to the description of the WHOQOL group. The domain scores were also calculated by multiplying the mean of all of the items included within the domain by four, and items proposed in the negative form were calculated by subtracting the given score from 6²³. The potential scores for all of the domain scores were 6 to 20, and all of the scores were transformed based on a scale that ranged from 0 to 100 as

an equation of $[(\text{raw score}-4)/16]\times 100$.

Statistical analysis

All of the independent predictors including age, sex, education, marriage status, illness, brain injury, presence of subarachnoid hemorrhage, craniotomy size, surgical approach and hospital charges were assessed and included in the statistical analysis. The dependent variables were the transformed scores of the 6 domains, 24 facets and total scores. First, all of the variables were compared between the case and control groups using the chi-squared test and t-test. Second, a reliability analysis using Cronbach's alpha and Pearson's correlation of the WHOQOL Korean version in both the patients and the control subjects was performed. Further analysis of the QOL value differences between the case and control subjects was conducted following an adjustment of the baseline differences using multivariate analysis. A subgroup analysis of the QOL values according to the presence of the subarachnoid hemorrhage, brain injury, craniotomy size and surgical approach was also conducted. In unruptured aneurysm patients, the QOL values according to craniotomy size were also compared with t-test. To evaluate the random effects in this study regarding the QOL in patients with an anterior circulation aneurysm and a good outcome, the differences of the hospital charges according to the contributing factor of the QOL in this population was compared using the t-test. A *p* value of less than 0.05 was considered significant using two tailed statistics. The data analyses were performed using Statistical Analysis System version 9.1.2.

Table 3. Validation of the Korean version of the WHOQOL scale in case and control subjects

Domains or facet (number of questions)	Cronbach's alpha in the control subjects (case subjects)	Correlation between the overall QOL and domain/facet in the control subjects (case subjects) [†]
Overall (4)	0.827 (0.835)	
PHY (12)	0.887 (0.894)	0.638 (0.678)
Facet 1 pain	0.814 (0.818)	-0.544 (-0.546)
Facet 2 energy	0.737 (0.777)	0.635 (0.634)
Facet 3 sleep	0.897 (0.878)	0.422 (0.529)
PSY (20)	0.895 (0.907)	0.727 (0.710)
Facet 4 positive feelings	0.686* (0.704)	0.596 (0.573)
Facet 5 thinking	0.660* (0.658*)	0.537 (0.556)
Facet 6 self esteem	0.801 (0.787)	0.610 (0.641)
Facet 7 body	0.781 (0.805)	0.520 (0.500)
Facet 8 negative feelings	0.819 (0.846)	-0.494 (-0.538)
IND (16)	0.921 (0.927)	0.613 (0.551)
Facet 9 mobility	0.783 (0.830)	0.453 (0.354)
Facet 10 activity	0.774 (0.788)	0.622 (0.567)
Facet 11 medication	0.888 (0.824)	-0.385 (-0.389)
Facet 12 work	0.924 (0.929)	0.540 (0.508)
SOC (12)	0.757 (0.741)	0.672 (0.656)
Facet 13 relationships	0.603* (0.612*)	0.712 (0.710)
Facet 14 support	0.500* (0.522*)	0.405 (0.340)
Facet 15 sex	0.736 (0.690*)	0.440 (0.413)
ENV (32)	0.926 (0.919)	0.720 (0.736)
Facet 16 safety	0.660* (0.598*)	0.591 (0.595)
Facet 17 home	0.753 (0.742)	0.569 (0.550)
Facet 18 finances	0.842 (0.850)	0.571 (0.568)
Facet 19 service	0.650* (0.607*)	0.499 (0.491)
Facet 20 information	0.775 (0.794)	0.575 (0.586)
Facet 21 leisure	0.813 (0.799)	0.538 (0.500)
Facet 22 environment	0.735 (0.715)	0.392 (0.425)
Facet 23 transportation	0.750 (0.477*)	0.436 (0.508)
SPI (4)	0.893 (0.874)	0.355 (0.438)
Facet 24 spiritual	0.893 (0.874)	0.355 (0.438)
Total (100)	0.968 (0.969)	

*Except for these facets, all of the facets showed good internal consistency, [†]All of the Pearson correlation coefficient values were significant at *p*<0.0001. WHOQOL : World Health Organization Quality of Life, QOL : quality of life, PHY : physical, PSY : psychological, IND : level of independence, SOC : social, ENV : environmental, SPI : spiritual domain

Further analysis of the QOL value differences between the case and control subjects was conducted following an adjustment of the baseline differences using multivariate analysis. A subgroup analysis of the QOL values according to the presence of the subarachnoid hemorrhage, brain injury, craniotomy size and surgical approach was also conducted. In unruptured aneurysm patients, the QOL values according to craniotomy size were also compared with t-test. To evaluate the random effects in this study regarding the QOL in patients with an anterior circulation aneurysm and a good outcome, the differences of the hospital charges according to the contributing factor of the QOL in this population was compared using the t-test. A *p* value of less than 0.05 was considered significant using two tailed statistics. The data analyses were performed using Statistical Analysis System version 9.1.2.

RESULTS

General characteristics

Gender was not significantly different between the case and control groups. However, the case group was significantly older, less educated, and had a higher percentage of solitary life or illness (Table 1). In this study, 16 of the 99 patients had two aneurysms, and they were all surgically treated with a single craniotomy and surgical approach. Most of the patients initially showed a favorable neurological status with a WFNS grade of less than 2 (94%) and a Hunt and Hess

grade of less than 2 (93%). There were 42 patients with ruptured aneurysms and the location order of the aneurysms were as follows: MCA, anterior communicating artery, PComA, ICA, anterior cerebral artery and anterior choroidal artery. A conventional craniotomy was performed on 55 patients, and a small craniotomy was performed on 44 patients. The pterional approach was used in 86 patients, and the supraorbital approach was performed in 13 patients. A brain injury was defined as a low density of more than 1 cm in the immediate postoperative brain CT scan. A symptomatic vasospasm was found in 5 patients and a hydrocephalus ventriculoperitoneal shunt was required in 3 of the patients. The GOS at 6 months was 4 in 9 patients and 5 in 90 patients. In contrast, the GDS at 6 months was 1 in 84 patients, 2 in 10 patients and 3 in 5 patients (Table 2).

Reliability and validity of the WHOQOL Korean version

The internal consistency and construct validity of the WHOQOL Korean version of the patient case and control subjects are given in Table 3. The Cronbach's alpha values for the total score were 0.968 and 0.969 in the control and patient case subjects, respectively. The alpha value for the domain and facet score ranged from 0.500 to 0.926 in the control subjects and 0.477 to 0.927 in patient case subjects. The alpha value for all of the domains was higher than 0.7 in the control and patient case subjects. Facet 4 (positive feelings), facet 5 (thinking), facet 13 (relationships), facet 14 (support), facet 16 (safety) and facet 19 (service) revealed that Cronbach's alpha was less than 0.7 in the control subjects. Facet 5 (thinking), facet 13 (relationships), facet 14 (support), facet 15 (sex), facet 16 (safety), facet 19 (service) and facet 23 (transportation) showed alpha values of less than 0.7 in the control subjects. The Pearson correlation between the domain scores and the overall QOL ranged from 0.355 for the SPI to 0.720 for the ENV in the control subjects and 0.438 for the SPI to 0.710 for the PSY in the patients, which suggests a statistically significant correlation in the control subjects ($p < 0.0001$). The correlation coefficient in the patient case subjects between the domain and the overall QOL scores ranged from 0.438 and 0.710 for the SPI and PSY, respectively.

Comparison of QOL values in the case and control groups

The total QOL values of the case group were significantly lower than that of the control group ($p = 0.004$). The overall QOL scores and QOL scores of all of the domains, with the exception of the PHY and SOC in the case group,

displayed significantly lower values than in the control group (Table 4). On the facet level, after an adjustment of all of the independent variables including age, education, marriage status and illness, facet 6 (self esteem), facet 7 (body), facet 9 (mobility), facet 10 (activity), facet 12 (work), facet 17 (home), facet 20 (information), facet 21 (leisure) and facet 24 (spiritual) in the case group were significantly lower than the control group (Table 4).

Subgroup analysis of the QOL values and hospital expenses in the case group

When the aneurysm patients were classified according to aneurysm rupture, there was no difference in any domain and facet between the ruptured and unruptured groups (not shown in Tables). With the exception of facet 5 (thinking) and facet 20 (information), the aneurysm patients with brain injury demonstrated lower QOL values than subjects without brain injury (Table 5). At the analysis for the whole aneurysm patients, according to the craniotomy type and surgical approach, the values for the total QOL, overall QOL and all of the domains except for the ENV were not significantly different. The QOL values for the ENV were higher in the small or supraorbital group than in the conventional or pterional/others group (Table 5, 6). The supraorbital group revealed higher values in the facet 18 (finances) and facet 21 (leisure) than the pterional/others group (Table 5). The small craniotomy group showed higher values of QOL in facet 4 (positive feelings), facet 16 (safety), facet 18 (finances), facet 21 (leisure) and facet 22 (environment) than in the conventional craniotomy group (Table 6). However, at the analysis for only the unruptured aneurysm patients, there

Table 4. Comparison of the WHOQOL values in case and control subjects

Domains or facets*	Case (n=99)	Control (n=85)	Crude p-value [†]	F-value	Adjusted p-value [‡]
Total	55.0±12.2	62.5±9.7	<0.001 [§]	8.547	0.004 [§]
Overall	53.6±17.6	63.3±14.1	<0.001 [§]	8.469	0.004 [§]
PHY	63.1±17.5	66.9±15.9	0.13	0.036	0.85
PSY	54.2±15.4	61.9±10.9	<0.001 [§]	6.377	0.012 [§]
IND	63.6±18.7	75.7±14.2	<0.001 [§]	9.129	0.003 [§]
SOC	53.0±11.8	57.3±11.6	0.015 [§]	1.691	0.19
ENV	50.6±12.6	57.4±11.8	<0.001 [§]	7.816	0.006 [§]
SPI	41.6±25.7	54.6±27.2	0.001 [§]	10.264	0.002 [§]
Facet 6 self esteem	53.2±19.5	64.6±16.5	<0.001 [§]	10.493	0.001 [§]
Facet 7 body	55.6±22.4	64.3±16.9	0.003 [§]	4.944	0.027 [§]
Facet 9 mobility	72.8±20.8	82.1±16.8	0.001 [§]	4.309	0.039 [§]
Facet 10 activity	61.8±21.2	73.7±15.6	<0.001 [§]	7.525	0.007 [§]
Facet 12 work	52.6±26.7	69.0±20.7	<0.001 [§]	10.437	0.001 [§]
Facet 17 home	48.2±18.1	56.9±16.5	0.001 [§]	7.925	0.005 [§]
Facet 20 information	47.0±18.4	56.9±14.2	<0.001 [§]	8.576	0.004 [§]
Facet 21 leisure	37.0±18.6	46.7±19.3	0.001 [§]	6.371	0.012 [§]
Facet 24 spiritual	41.6±25.7	54.6±27.2	<0.001 [§]	10.264	0.002 [§]

*The facets that were not shown here were not significantly different between the two groups, [†]t-test was used. [‡]Multivariate analysis was used, [§]There was a statistical significance between the two groups. WHOQOL : World Health Organization Quality of Life, PHY : physical, PSY : psychological, IND : level of independence, SOC : social, ENV : environmental, SPI : spiritual domain

Table 5. QOL according to surgical approach and brain injury in the aneurysm patients

Domains or facets	Surgical approach			Brain injury		
	Supraorbital (n=13)	Pterional or others (n=86)	p-value*	Yes (n=21)	No (n=78)	p-value*
Overall	52.8±19.7	53.7±17.4	0.86	49.4±12.9	54.8±18.5	0.21
PHY	66.5±18.0	62.6±17.5	0.46	62.6±17.6	63.3±17.6	0.88
PSY	59.2±16.2	53.5±15.2	0.21	52.4±12.6	54.7±16.1	0.53
IND	58.5±23.3	64.4±17.9	0.28	62.7±17.0	63.9±19.2	0.80
SOC	54.3±11.2	52.8±11.9	0.68	51.2±9.0	53.5±12.4	0.43
ENV	58.1±13.6	49.5±12.1	0.022 [†]	48.2±9.1	51.3±13.3	0.32
SPI	40.3±20.9	41.7±26.4	0.85	41.3±27.7	41.6±25.3	0.96
Facet 4 positive feelings	50.9±16.8	43.9±16.8	0.16	41.0±14.8	45.9±17.4	0.24
Facet 5 thinking	51.9±16.2	49.5±16.6	0.63	43.4±11.0	51.6±17.3	0.012 [†]
Facet 16 safety	50.9±16.3	44.1±15.8	0.15	46.1±13.9	44.7±16.5	0.73
Facet 18 finances	65.8±16.4	46.3±21.2	0.018 [†]	44.0±17.8	50.2±22.5	0.24
Facet 20 information	51.9±18.4	46.3±18.4	0.31	39.8±14.3	49.0±18.9	0.043 [†]
Facet 21 leisure	48.5±17.7	35.3±18.3	0.021 [†]	31.5±13.3	38.5±19.6	0.06
Facet 22 environment	62.5±14.2	55.2±16.4	0.13	56.2±15.1	56.1±16.6	0.98

The facets that were not shown here were not significantly different between the two groups. *p-value was calculated with t-test, [†]There was a statistical significance between the two groups. QOL : quality of life, PHY : physical, PSY : psychological, IND : level of independence, SOC : social, ENV : environmental, SPI : spiritual domain

Table 6. QOL according to the craniotomy type used in the all and unruptured aneurysm patients

Domains or facets	All aneurysm patients (n=99)			Unruptured aneurysm patients (n=57)		
	Small craniotomy (n=44)	Conventional craniotomy (n=55)	p-value*	Small craniotomy (n=30)	Conventional craniotomy (n=27)	p-value*
Overall	55.6±21.0	52.0±14.2	0.33	57.7±22.7	50.6±14.3	0.16
PHY	65.2±18.2	61.5±17.0	0.30	65.6±16.6	60.3±19.8	0.27
PSY	56.2±18.9	52.7±11.8	0.29	56.2±20.3	51.2±13.1	0.27
IND	64.8±20.8	62.7±16.9	0.58	62.8±21.9	60.5±18.9	0.67
SOC	53.5±13.1	52.7±10.7	0.74	52.2±14.1	53.4±11.0	0.71
ENV	54.1±15.3	47.8±9.1	0.019 [†]	53.6±16.6	47.7±9.5	0.10
SPI	40.9±25.1	42.1±26.3	0.81	39.3±25.7	42.1±26.3	0.69
Facet 4 positive feelings	48.8±20.0	41.7±13.4	0.046 [†]	49.1±21.3	40.0±13.6	0.058
Facet 5 thinking	52.2±18.6	47.9±14.4	0.19	53.3±20.5	47.6±15.1	0.24
Facet 16 safety	48.7±17.9	42.1±13.6	0.042 [†]	48.3±17.7	42.8±14.1	0.20
Facet 18 finances	56.2±22.3	43.0±19.3	0.002 [†]	58.7±24.4	39.5±20.4	0.002 [†]
Facet 20 information	49.8±21.1	44.8±15.7	0.19	48.1±21.9	44.2±12.3	0.40
Facet 21 leisure	42.1±20.7	32.9±15.7	0.014 [†]	43.5±22.3	30.5±16.2	0.015 [†]
Facet 22 environment	60.3±14.5	52.8±16.8	0.021 [†]	59.3±14.3	54.1±17.3	0.22

The facets that were not shown here were not significantly different between the two groups. *p-value was calculated with t-test, [†]There was a statistical significance between the two groups. QOL : quality of life, PHY : physical, PSY : psychological, IND : level of independence, SOC : social, ENV : environmental, SPI : spiritual domain

was a significant difference between two groups according to craniotomy size in facet 18 (finances) and facet 21 (leisure) (Table 6). Of the total expenses paid for treatment during the hospitalization period, the patients who underwent a small craniotomy paid lower hospital charges than those treated with a conventional craniotomy ($p=0.006$), while the patients treated with the supraorbital approach did not have lower hospital expenses than those treated with the pterional/others surgical approach ($p=0.25$) (Fig. 3).

DISCUSSION

Min et al.¹¹⁾ first validated the WHOQOL instrument-Korean

version, which has not been used for the evaluation of QOL in patients with cerebrovascular disease. In this study, the WHO-QOL instrument-Korean version was first used to assess the intracranial aneurysm patients treated with clipping surgery. Consistent with previous results of QOL in the general Korean population, our study showed greater alpha values than 0.7 for all of the domains in both the control and case subjects, while facet 5 (thinking), facet 15 (sex), facet 16 (safety) and facet 23 (transportation) fell below 0.7, including facet 13 (relationships), facet 14 (support) and facet 19 (service), which were lower than the results obtained by Min et al.¹¹⁾. The Pearson correlation between each domain and the facet scores in both the overall QOL and the domain/facet was significantly high. Consistent with

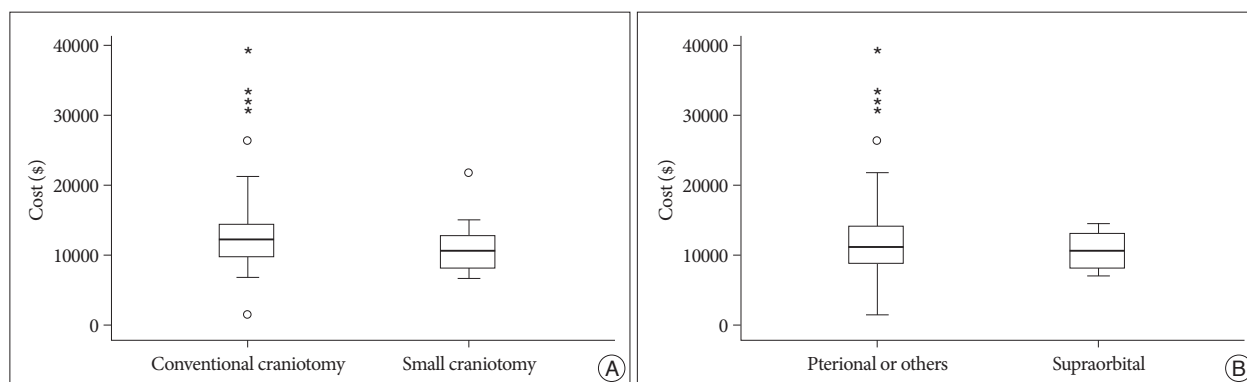


Fig. 3. Comparison of hospital charges between the type of craniotomy and approach. There is a significant difference between conventional and small craniotomy ($p=0.006$, A). On the contrary, there was no difference between the supraorbital and pterional approaches ($p=0.25$, B).

the results of Min et al., the correlation value for the SOC between the overall QOL and domain was relatively low in the control and case subjects (0.355 and 0.438, respectively). Therefore, the WHOQOL Korean version may be valid and reliable for the assessment of QOL in patients with an anterior circulation aneurysm.

Although the patients showed good GOS and GDS scores, patients treated with anterior circulation aneurysms regardless of subarachnoid hemorrhage demonstrated lower QOL scores for the total, overall, PSY, IND, ENV and SPI scores compared with normal control subjects (Table 4). These findings suggest that the QOL in aneurysm patients with neurologically good outcomes is an important outcome indicator, which is consistent with the findings of Kim et al.⁹. In addition, the subgroup analysis revealed a contrast with previous studies of intracranial aneurysm patients regarding their QOL according to surgical methods. We found that the smaller the craniotomy size, the better the ENV score. Our results also showed a better score for the ENV in the supraorbital group compared with the pterional/others group (Table 5). Regarding facets, facet 18 (finances) and facet 21 (leisure) were significantly different according to the type of craniotomy and surgical approach in anterior circulation aneurysm patients regardless of exclusion of subarachnoid hemorrhage patients (Table 5, 6). The hospital expenses did not show a significant difference according to the surgical approach, bleeding of the aneurysm and brain injury, while in the small craniotomy group, the patients had less expensive hospital charges during their admission period (Fig. 3). Therefore, these findings suggest that the differences in the QOL according to the craniotomy type may not result from random effects. Interestingly, patients with brain injury showed a low score for facet 5 (thinking) and facet 20 (information). This finding indicates that the WHOQOL instrument is a very sensitive tool for patients with mild cognitive dysfunction.

Recently, studies have reported that limited craniotomies require minimal brain retraction and thus significantly decrease approach-related morbidity^{2,12,14,15,19}. However, the safety and efficacy of keyhole craniotomy is still controversial because of the uncontrollability of the insurmountable brain swelling at the

opening the dura and the inability to perform partial or complete lobectomies²². We performed a modified small pterional craniotomy on patients with anterior circulation aneurysms, which is unlike the pterional keyhole approach¹⁴. Regardless of the surgical approach, the craniotomy size may affect the QOL of aneurysm patients, especially in the environmental domains including finance and leisure.

Our research showed additional beneficial aspects of minimally invasive operations, but there are several limitations of the study design, including the low participation rate, small sample size and the retrospective review. In spite of multivariate analysis, as there was not a matched sampling of control groups, therefore, we should consider the sampling bias. In the future, a prospective randomized study regarding the safety and efficacy of minimally invasive operations for anterior circulation aneurysms will be required.

CONCLUSION

The WHOQOL instrument-Korean version is a useful tool for the measurement of QOL in patients who were surgically treated for intracranial aneurysms. The QOL in patients who experienced an anterior circulation aneurysm surgery, despite having a good neurological outcome, was low in all of the domains except for the physical and social domains. The craniotomy size may affect the QOL in patients who underwent an anterior circulation aneurysm surgery and had a good outcome.

• Acknowledgements

The authors give a special thanks to Ye-Kyung Shin and Min-Jung Ham for data handling. The statistical consultation was supported by the Catholic Research Coordinating Center of the Korea Health 21 R&D Project (A070001), Ministry of Health & Welfare, Republic of Korea.

References

- Cedzich C, Roth A : Neurological and psychosocial outcome after subarachnoid haemorrhage, and the hunt and hess scale as a predictor of clinical outcome. *Zentralbl Neurochir* 66 : 112-118, 2005
- Chen L, Tian X, Zhang J, Huang Y, Chen E, Lan Q : Is eyebrow approach suitable for ruptured anterior circulation aneurysms on early stage: a prospective study at a single institute. *Acta Neurochir (Wien)*

- 151 : 781-784; discussion 784, 2009
3. Deruty R, Patet JD, Mottolese C, Portilla F : Long-term outcome of the management of ruptured intracranial aneurysm. Review of 328 consecutive patients treated over a period of 12 years. *Neurol Res* 10 : 217-220, 1988
 4. Hackett ML, Anderson CS : Health outcomes 1 year after subarachnoid hemorrhage : an international population-based study. The Australian Cooperative Research on Subarachnoid Hemorrhage Study Group. *Neurology* 55 : 658-662, 2000
 5. Hop JW, Rinkel GJ, Algra A, van Gijn J : Changes in functional outcome and quality of life in patients and caregivers after aneurysmal subarachnoid hemorrhage. *J Neurosurg* 95 : 957-963, 2001
 6. Hütter BO, Gilsbach JM, Kreitschmann I : Quality of life and cognitive deficits after subarachnoid haemorrhage. *Br J Neurosurg* 9 : 465-475, 1995
 7. Hütter BO, Kreitschmann-Andermahr I, Gilsbach JM : Health-related quality of life after aneurysmal subarachnoid hemorrhage : impacts of bleeding severity, computerized tomography findings, surgery, vasospasm, and neurological grade. *J Neurosurg* 94 : 241-251, 2001
 8. Kassam NF, Torner JC, Haley EC Jr, Jane JA, Adams HP, Kongable GL : The International Cooperative Study on the Timing of Aneurysm Surgery. Part 1 : overall management results. *J Neurosurg* 73 : 18-36, 1990
 9. Kim DH, Haney CL, Van Ginhoven G : Utility of outcome measures after treatment for intracranial aneurysms : a prospective trial involving 520 patients. *Stroke* 36 : 792-796, 2005
 10. King JT Jr, Horowitz MB, Kassam AB, Yonas H, Roberts MS : The short form-12 and the measurement of health status in patients with cerebral aneurysms : performance, validity, and reliability. *J Neurosurg* 102 : 489-494, 2005
 11. Min SK, Kim KI, Lee CI, Jung YC, Suh SY, Kim DK : Development of the Korean versions of WHO Quality of Life scale and WHOQOL-BREF. *Qual Life Res* 11 : 593-600, 2002
 12. Mitchell P, Vindlacheruvu RR, Mahmood K, Ashpole RD, Grivas A, Mendelow AD : Supraorbital eyebrow minicraniotomy for anterior circulation aneurysms. *Surg Neurol* 63 : 47-51; discussion 51, 2005
 13. Molyneux AJ, Kerr RS, Yu LM, Clarke M, Sneade M, Yarnold JA, et al. : International subarachnoid aneurysm trial (ISAT) of neurosurgical clipping versus endovascular coiling in 2143 patients with ruptured intracranial aneurysms : a randomised comparison of effects on survival, dependency, seizures, rebleeding, subgroups, and aneurysm occlusion. *Lancet* 366 : 809-817, 2005
 14. Nathal E, Gomez-Amador JL : Anatomic and surgical basis of the sphenoid ridge keyhole approach for cerebral aneurysms. *Neurosurgery* 56 : 178-185; discussion 178-185, 2005
 15. Park HS, Park SK, Han YM : Microsurgical experience with supraorbital keyhole operations on anterior circulation aneurysms. *J Korean Neurosurg Soc* 46 : 103-108, 2009
 16. Powell J, Kitchen N, Heslin J, Greenwood R : Psychosocial outcomes at three and nine months after good neurological recovery from aneurysmal subarachnoid haemorrhage : predictors and prognosis. *J Neurol Neurosurg Psychiatry* 72 : 772-781, 2002
 17. Proust F, Martinaud O, Gérardin E, Derrey S, Levègue S, Bioux S, et al. : Quality of life and brain damage after microsurgical clip occlusion or endovascular coil embolization for ruptured anterior communicating artery aneurysms : neuropsychological assessment. *J Neurosurg* 110 : 19-29, 2009
 18. Reisch R, Perneckzy A : Ten-year experience with the supraorbital sub-frontal approach through an eyebrow skin incision. *Neurosurgery* 57 : 242-255; discussion 242-255, 2005
 19. Reisch R, Perneckzy A, Filippi R : Surgical technique of the supraorbital key-hole craniotomy. *Surg Neurol* 59 : 223-227, 2003
 20. Schuiling WJ, Rinkel GJ, Walchenbach R, de Weerd AW : Disorders of sleep and wake in patients after subarachnoid hemorrhage. *Stroke* 36 : 578-582, 2005
 21. Solheim O, Eloqayli H, Muller TB, Unsgaard G : Quality of life after treatment for incidental, unruptured intracranial aneurysms. *Acta Neurochir (Wien)* 148 : 821-830; discussion 830, 2006
 22. Teo C : The concept of minimally invasive neurosurgery. *Neurosurg Clin N Am* 21 : 583-584, v, 2010
 23. The WHOQOL Group : Development of the World Health Organization WHOQOL-BREF quality of life assessment. *Psychol Med* 28 : 551-558, 1998
 24. Yasargil MG, Fox JL : The microsurgical approach to intracranial aneurysms. *Surg Neurol* 3 : 7-14, 1975