Risk-Adjusted Analyses of the Effects of Hospital and Surgeon Volumes on Postoperative Complications and the Modified Rankin Scale After Clipping of Unruptured Intracranial Aneurysms in Japan

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Abstract

The present study conducted risk-adjusted analyses to investigate the impacts of hospital and surgeon volumes on postoperative complications and the modified Rankin scale (mRS) after intracranial clipping of unruptured aneurysms, and to discuss the efficacy of relevant policy changes. Among 107 Japanese institutions, physician-reported data for 702 unruptured aneurysm patients were registered between December 2006 and April 2007. Postoperative complications and the mRS at the time of discharge were independently regressed against hospital and surgeon volumes, aneurysm size, aneurysm location, and comorbidities. Aneurysm size was a significant predictor of the overall outcomes. After adjusting for prominent confounders, hospital volume did not show any significant associations with postoperative complications (odds ratio [OR] 0.75, 95% confidence interval [CI] 0.34–1.68, p = 0.49) or the mRS (OR 0.60, 95% CI 0.19–1.93, p = 0.39). Higher surgeon volume (>100) was associated with lower mRS scores (OR 0.40, 95% CI 0.20–0.83, p = 0.013), but had no significant relationship with postoperative complications (OR 0.72, p = 0.47). Our risk-adjusted analyses showed no significant relationships between hospital volume and comorbidities. Therefore, the justification for hospital volume-based policies remains unclear. Prospective risk-adjusted volume-based studies are required for future evidence-based referral policies.

Key words: clipping, hospital volume, intracranial aneurysm, modified Rankin scale, surgeon volume

Introduction

A number of studies have elucidated that large hospital and surgeon volumes are associated with better patient outcomes after many complex surgical procedures. Most previous reports within neurosurgery have described volume-outcomes in the United States for surgical and endovascular treatments of ruptured or unruptured aneurysms, adult intracranial tumor resection, and pediatric brain tumor resection. These previous volume-based studies on cerebral aneurysms have a lot in common. Specifically, intracranial hospital mortality was the predominant outcome, and morbidity was defined as discharge other than to the patient’s home (i.e. discharge to a nursing home or rehabilitation hospital). However, the interpretation of these investigations is somewhat constrained by several limitations that arise from the methods of risk adjustment for disease severity and comorbidities, since these studies obtained their data from administrative claims databases or coded discharge summaries, rather than from case notes. Although the sample sizes are large, these routinely corrected databases have potentially unsolved problems, and lack information on factors, such as aneurysm size and location, that are considered to be vital for evaluating outcomes. Furthermore, these databases also lack reliable information on the ac-
tual incidence of postoperative complications or disability. Although ‘discharge other than to home’ is an available surrogate endpoint for the disability status, the validity of such a measurement has not been fully confirmed. A previous Japanese study found no relationship between case volume and outcome for unruptured aneurysm clipping, but the outcome variables were not adjusted for risk factors such as aneurysm size.11)

The present study examined the effects of hospital and surgeon volumes on the outcomes after intracranial clipping of unruptured aneurysms, after adjustment for prominent risk factors and possible confounders, based on highly detailed data based on medical records, including pre-existing comorbidities, aneurysm size, aneurysm location, hospital volumes, and surgeon volumes, for clipping of unruptured intracranial aneurysms. The indicators of morbidity were evaluated from medical record-based data on the occurrence of postoperative complications and the modified Rankin scale (mRS), which is a physician-reported measure of global disability (especially physical disability) and the need for assistance, with six categories (grades 0 to 5) of stroke severity ranging from “no symptoms at all” to “severe disability.”20)

Materials and Methods

I. Data collection process

This survey targeted all 386 centers designated as advanced teaching hospitals by The Japan Neurosurgical Society (JNS). These centers perform more than 100 neurosurgical operations annually, including 30 or more cases of central nervous system tumors, intracranial aneurysms, and arteriovenous malformations.

All 386 hospitals were sent a letter by the chief director of the JNS on November 18, 2006, offering them the opportunity to participate in this survey. The details of the survey method were also announced on the official homepage of the JNS website. Thereafter, each hospital received an e-mail from the JNS office with an attached file containing the questionnaire format (Microsoft Excel®; Microsoft Corporation, Redmond, Wash., U.S.A.). Each neurosurgeon voluntarily filled in the answers to the questions in the file by referring to the medical records of patients who underwent intracranial clipping for unruptured aneurysms from December 1, 2006 to April 30, 2007, and then returned the file to the JNS office as an e-mail attachment.

To limit the confounding effects of pre-existing neurological deficits, we excluded patients with a prior diagnosis of subarachnoid hemorrhage. This study was ethically approved by our Institutional Review Board.

II. Content of the questionnaire

The questionnaire included hospital and surgeon volumes as primary predictors of outcomes, patient background data and aneurysm characteristics as covariates, and postoperative complications and the mRS as outcomes.

III. Primary predictors of outcomes

Each hospital was asked for the numbers of clippings for both unruptured and ruptured aneurysms performed in 2005. Hospital volume was categorized into one of the following three groups: <50, 50–99, and ≥100.

Both the operating surgeon and the leader of the operating team for each case were asked for the number of their clipping procedures performed as an operating surgeon. We defined surgeon volume as the greater of the volume of the operating surgeon and the volume of the leader of the operating team. Surgeon volume was divided into the following three groups: <50, 50–99, and ≥100.

IV. Covariates

The patient background factors examined were age, sex, and comorbidities, including hypertension, diabetes mellitus, hyperlipidemia, history of ischemic heart diseases, and history of cerebrovascular diseases. History of cerebrovascular diseases included the presence of an asymptomatic infarction detected by imaging.

The aneurysm characteristics included the number of aneurysms treated, aneurysm location, on the internal carotid artery, middle cerebral artery (MCA), anterior cerebral artery (ACA), vertebral artery (VA), and others, maximum size of aneurysm, and occurrence of intraoperative rupture.

We also examined the opportunities for detecting the aneurysm in each patient, including outpatient clinic visits for examination of headaches and other symptoms, and mass screening for asymptomatic brain diseases using magnetic resonance imaging, referred to as No Dokku (brain dock) in Japan.22)

V. Outcomes

The primary outcome measures were defined as postoperative complications, including cerebral infarction, intracranial re-bleeding, hydrocephalus, septic meningitis, and pulmonary embolism. The mRS at the time of discharge was used as a postoperative functional outcome measure. We also assessed the length of stay as a secondary outcome measure.
VI. Statistical analysis

Correlation coefficients (Spearman’s rho) were calculated for hospital or surgeon volume and aneurysm size. Multivariate regression analyses used generalized estimating equations (GEEs) to allow observations to be clustered by hospital and surgeon volumes. Application of GEEs is a standard statistical technique used when variables are expected to cluster within predetermined groups.15,19

A logistic regression model fitted with GEEs was used to examine the relationships between postoperative complications and provider volumes, after adjustment for patient characteristics, comorbidities, and aneurysm characteristics. A proportional odds model fitted with GEEs was adopted to verify the associations between provider volumes and the mRS. A proportional hazard model fitted with GEEs was applied to clarify whether provider volumes affected the length of stay.

We presented the intensities of the relationships between dependent and independent variables as odds ratios (ORs) or hazard ratios (HRs) and 95% confidence intervals (CIs) relative to a reference group. The threshold for significance was set at p < 0.05. All statistical analyses were conducted using SAS software version 9.1 (SAS Institute Inc., Cary, N.C., U.S.A.).

Results

I. Baseline characteristics

We collected data for a total of 702 patients with unruptured aneurysms treated by intracranial clipping at 107 hospitals during the survey period. Table 1 shows the baseline characteristics of the 702 cases. Overall, the patients were likely to be female (63.7%). The mean age was 61.1 ± 9.8 years. Regarding aneurysm size, 628 patients had aneurysms of < 10 mm. No in-hospital deaths were encountered. Regarding postoperative complications, 42 (6.0%) patients had cerebral infarction, 9 (1.3%) had intracranial re-bleeding, 4 (0.6%) had septic meningitis, 4 (0.6%) had pulmonary embolism, and 2 (0.3%) had hydrocephalus.

Regarding the mRS, 633 patients (90.2%) were scored as grade 0 (no symptoms at all), 44 (6.3%) as grade 1 with no significant disability (despite symptoms, able to carry out all usual duties and activities), 14 (2.0%) as grade 2 with slight disability (unable to perform all previous activities but able to look after own affairs without assistance), 5 (0.7%) as grade 3 with moderate disability (requiring some help but able to walk without assistance), and 4 (0.6%) as grade 4 with moderately severe disability (unable to walk without assistance and unable to attend to own bodily needs without assistance). None of the patients were scored as grade 5 with severe disability (bedridden, incontinent, and requiring constant nursing care and attention).

II. Correlations of hospital and subject volumes with aneurysm size

Table 2 shows the distributions of the provider volumes. Among the 107 institutions, the average number of clippings in 2005 was 39.6. Table 2 also shows the correlations of hospital and surgeon volumes with aneurysm size. The correlation coefficients (Spearman’s rho) were -1.71 (p < 0.01) between hospital volume and aneurysm size and -0.13 (p < 0.01) between surgeon volume and aneurysm size.

III. Multivariate analyses

Postoperative complications: The logistic regression model identified significant factors associated
with postoperative complications as aneurysm size of >10 mm (OR 3.18, 95% CI 1.28–7.89, p = 0.012), age (OR 1.40, 95% CI 1.04–1.89, p = 0.027), and intraoperative rupture (OR 3.32, 95% CI 1.06–10.74, p = 0.04) (Table 3). Neither hospital volume nor surgeon volume was a significant predictor after adjustment for these confounders.

### Table 2 Correlations of hospital and surgeon volumes with aneurysm size

<table>
<thead>
<tr>
<th>Aneurysm size</th>
<th>Hospital volume</th>
<th>Surgeon volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–49 (n = 300)</td>
<td>72 (24.0%)</td>
<td>15 (16.5%)</td>
</tr>
<tr>
<td>50–99 (n = 297)</td>
<td>100 (33.7%)</td>
<td>50–99 (n = 102)</td>
</tr>
<tr>
<td>≥ 100 (n = 105)</td>
<td>49 (46.7%)</td>
<td>≥ 100 (n = 505)</td>
</tr>
</tbody>
</table>

### Table 3 Results of multivariate analyses

<table>
<thead>
<tr>
<th>Variable and category</th>
<th>Postoperative complications</th>
<th>Modified Rankin scale</th>
<th>Length of stay</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR 95% CI p Value</td>
<td>OR 95% CI p Value</td>
<td>HR 95% CI p Value</td>
</tr>
<tr>
<td>Hospital volume</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–49</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>50–99</td>
<td>1.19 (0.65–2.17) 0.57</td>
<td>0.91 (0.46–1.80) 0.79</td>
<td>1.26 (0.99–1.60) 0.057</td>
</tr>
<tr>
<td>≥ 100</td>
<td>0.75 (0.34–1.68) 0.49</td>
<td>0.60 (0.19–1.93) 0.39</td>
<td>4.36 (2.59–7.32) &lt;0.0001</td>
</tr>
<tr>
<td>Surgeon volume</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–49</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>50–99</td>
<td>1.56 (0.54–4.52) 0.41</td>
<td>0.73 (0.27–2.00) 0.54</td>
<td>1.05 (0.73–1.50) 0.81</td>
</tr>
<tr>
<td>≥ 100</td>
<td>0.72 (0.29–1.78) 0.47</td>
<td>0.40 (0.20–0.83) 0.013</td>
<td>1.10 (0.83–1.47) 0.50</td>
</tr>
<tr>
<td>Number of aneurysms treated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>≥ 2</td>
<td>0.35 (0.09–1.44) 0.15</td>
<td>1.72 (0.70–4.22) 0.23</td>
<td>0.97 (0.78–1.19) 0.75</td>
</tr>
<tr>
<td>Location of aneurysm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle cerebral artery</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Internal carotid artery</td>
<td>0.91 (0.46–1.79) 0.78</td>
<td>1.46 (0.73–2.95) 0.29</td>
<td>0.85 (0.67–1.08) 0.18</td>
</tr>
<tr>
<td>Anterior cerebral artery</td>
<td>1.41 (0.72–2.78) 0.32</td>
<td>2.35 (1.33–4.17) 0.0034</td>
<td>0.91 (0.72–1.13) 0.39</td>
</tr>
<tr>
<td>Vertebral artery</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Size of aneurysm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;5 mm</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>5–10 mm</td>
<td>1.13 (0.51–2.51) 0.75</td>
<td>1.91 (0.99–3.68) 0.055</td>
<td>0.90 (0.77–1.05) 0.18</td>
</tr>
<tr>
<td>≥ 10 mm</td>
<td>3.18 (1.28–7.89) 0.012</td>
<td>4.85 (2.11–11.11) 0.0002</td>
<td>0.73 (0.54–0.99) 0.041</td>
</tr>
<tr>
<td>Intraoperative rupture</td>
<td>3.32 (1.06–10.47) 0.04</td>
<td>3.88 (1.29–11.67) 0.016</td>
<td>0.65 (0.48–0.88) 0.0046</td>
</tr>
<tr>
<td>Age (10-year age increase)</td>
<td>1.40 (1.04–1.89) 0.027</td>
<td>1.20 (0.84–1.70) 0.31</td>
<td>0.97 (0.91–1.03) 0.35</td>
</tr>
<tr>
<td>Sex (male)</td>
<td>0.82 (0.43–1.55) 0.54</td>
<td>0.76 (0.45–1.29) 0.31</td>
<td>1.12 (0.94–1.33) 0.22</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>1.69 (0.66–4.33) 0.27</td>
<td>1.42 (0.56–3.63) 0.46</td>
<td>0.92 (0.67–1.28) 0.64</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1.28 (0.68–2.4) 0.45</td>
<td>0.73 (0.42–1.27) 0.27</td>
<td>1.03 (0.89–1.19) 0.74</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>0.92 (0.44–1.9) 0.81</td>
<td>0.55 (0.27–1.0) 0.090</td>
<td>0.96 (0.81–1.14) 0.67</td>
</tr>
<tr>
<td>History of ischemic heart diseases</td>
<td>2.04 (0.54–7.65) 0.29</td>
<td>2.34 (0.50–11.02) 0.28</td>
<td>1.55 (1.15–2.08) 0.0041</td>
</tr>
<tr>
<td>History of cerebrovascular diseases</td>
<td>1.17 (0.55–2.46) 0.68</td>
<td>2.01 (1.05–3.83) 0.034</td>
<td>1.02 (0.85–1.23) 0.82</td>
</tr>
<tr>
<td>Opportunity to detect the lesion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outpatient clinic visit</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Mass screening</td>
<td>1.01 (0.54–1.88) 0.98</td>
<td>1.13 (0.54–2.36) 0.75</td>
<td>1.06 (0.88–1.26) 0.55</td>
</tr>
</tbody>
</table>

CI: confidence interval, HR: hazard ratio, OR: odds ratio.
cases (Table 3). Surgeon volume was not a significant independent predictor of the length of stay. Other significant predictors that increased the length of stay were larger size of aneurysm (HR 0.73, 95% CI 0.54–0.99, p = 0.041), aneurysm in the VA (HR 0.64, 95% CI 0.44–0.94, p = 0.021), and intraoperative rupture (HR 0.65, 95% CI 0.48–0.88, p = 0.0046).

Discussion

I. Necessity for risk adjustment

Several unavoidable limitations commonly exist in the databases used in most previous studies on volume-outcome analyses for cerebral aneurysms, including the Nationwide Inpatient Sample, and the University Health Systems Consortium data. Most notably, these databases lack information that is considered vital for estimating the risk of unruptured aneurysm clipping, namely aneurysm size and location. These studies repeatedly concluded that patients recover better when treated in a high volume center. However, the data available from these studies do not permit readers to reach this conclusion with certainty.

In the present study, we prospectively collected more inclusive data that contained information on the initial illness severity and comorbidities. The results clearly showed that aneurysm size was the most significant predictor of surgical outcomes of unruptured aneurysms, since an aneurysm size of ≥ 10 mm was significantly associated with more postoperative complications, higher mRS scores, and longer length of stay. Furthermore, our study revealed that high volume centers tended to select patients with smaller aneurysms. This finding strongly indicates that adjustment for aneurysm size must be carried out, since this selection bias will cause misleading results of better outcomes in high volume centers. The regression analyses in the present study successfully ruled out this bias problem.

II. Outcome measurement

The preceding studies mainly mentioned mortality and ‘discharge other than to home’ as outcomes, because their databases did not include full assessments of morbidity. However, mortality figures are relatively crude indicators of outcome, at least in neurosurgery. Furthermore, a recent study did not find a statistically significant volume-mortality relationship, and this may simply reflect the recent lower mortality rates relative to those in previous studies. A previous Japanese study also found a mortality rate of 0.2% (9/4396) for patients who underwent clipping for unruptured aneurysm. Although ‘discharge other than to home’ was associated with the mRS, it is still considered to be a crude indicator.

Our study collected more detailed outcomes, including postoperative complications, and directly assessed the mRS scores. In the data collection process, preoperative comorbidities and postoperative complications were clearly differentiated. Furthermore, the relevant data for each individual patient were provided by the neurosurgeon in charge, so the reliability of the data could be more highly guaranteed compared to that provided by non-physician staff.

The mRS is a physician-reported measure that is valuable for assessing functional recovery of cerebrovascular disease patients at the time of discharge. The validity and reliability of the mRS have been repeatedly confirmed. A single-center study reported an inverse relationship between surgeon volume and the mRS. Our study is the first to investigate risk-adjusted volume-mRS relationships in a nationwide multicenter setting.

III. Hospital volume and outcomes

After adjusting for important confounders, postoperative complications and the mRS were not significantly associated with hospital volume. Therefore, our results are not compatible with those in previous reports based in the United States. In the United States, growing interest in volume-outcome relationships has bolstered relevant policy changes, including regionalization to high hospital volume centers. Such a policy has also been proposed in Japan. The results of the present study do not justify any hospital volume-based policies, at least in Japanese clinical settings, and provide an important message to all volume-outcome researchers in any country that risk adjustment is indispensable.

IV. Role of surgeon volume

Surgeon volume may exert different effects on outcomes compared to hospital volume. In the present study, length of stay was associated with hospital volume but not with surgeon volume. These findings suggest that a reduced length of stay may reflect hospital factors, such as nursing and use of clinical pathways, rather than the skill of the surgeon.

On the other hand, the mRS was associated with surgeon volume but not with hospital volume. In the present study, we defined surgeon volume as the
greater of the volumes of the operating surgeon and the leader of the operating team. In an additional analysis not reported here, we used the volume of the operating surgeon as surgeon volume, and found that the overall results were similar to those of the present analysis. If a high surgeon volume is related to a better outcome, the question arises as to whether young surgeons should perform this type of surgery due to their low volumes. We believe that young surgeons should perform this type of surgery, since they need to learn surgical techniques step by step through on-the-job training. In teaching hospitals in particular, a skilled surgeon must educate resident surgeons and at the same time maintain good outcomes. Our approach to quantifying surgeon volume may lead to improvements in evaluating the abilities of individual operating teams. Our results suggest that a low-volume operating surgeon supported by a high-volume assistant surgeon could finish an operation as successfully as a high-volume operating surgeon.

V. Limitations

Several limitations are acknowledged. The rate of cerebral infarction in this study (6%) might be lower than expected, when compared to the previous study by the International Study of Unruptured Intracranial Aneurysms Investigators, where the infarction rate was 10% for surgical cases.21) It is possible that among all 386 centers, the 107 participating ones studied here might be more experienced centers than the other 279 non-participating ones. Data collection done on a voluntary basis might have caused a bias whereby poor outcome cases were missed. Another concern is the self-reporting of complications and outcome; the complete inclusion of cases and endpoints could not be guaranteed using this method.

VI. Conclusion

Our risk-adjusted analyses revealed no significant associations between hospital volume and comorbidities for clipping of unruptured aneurysms. Therefore, the justification for hospital volume-based policies remains unclear, at least in Japanese clinical settings. Prospective risk-adjusted volume-outcome studies are required to provide more valid data for future healthcare delivery systems.

Acknowledgments

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We thank Ms. Yumi Fujimaki of the office of The Japan Neurosurgical Society for administrative assistance.

References

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Appendix

The university hospitals that participated in the present survey were: Sapporo Medical University, Sapporo, Hokkaido; Hiroshima University, Hiroshima, Hiroshima; Osaka University, Osaka, Osaka; Keio University, Tokyo, Tokyo; Nippon Medical School, Tokyo; Tokyo Women’s Medical University, Tokyo; Tokyo Medical and Dental University, Tokyo; the University of Tokyo, Tokyo; Tokyo Medical University Kasumigaura Hospital, Ibaraki; Tokai University, Isehara, Kanagawa; University of Yamanashi, Kofu, Yamanashi; Shinshu University, Matsumoto, Nagano; Kanazawa University, Kanazawa, Ishikawa; University of Fukui, Fukui; Gifu University, Gifu; Nara Medical University, Kashihara, Nara; Kyoto University, Kyoto; Kyoto Prefectural University of Medicine, Kyoto; Osaka City University, Osaka; Kinki University, Osakasayama, Osaka; Kobe University, Kobe, Hyogo; The University of Tokushima, Tokushima; Kagawa University, Kagawa; Ehime University, Toon, Ehime; Okayama University, Okayama; Shimane University, Izumo, Shimane; University of Occupational and Environmental Health, Kitakyushu, Fukuoka; Kurume University, Kurume, Fukuoka; Kyushu University, Fukuoka; Fukuoka University, Fukuoka; Kumamoto University, Kumamoto; University of Miyazaki, Miyazaki; and Kagoshima University, Kagoshima.

The non-university hospitals that participated were: Ashikaga Red Cross Hospital, Ashikaga, Tochigi; Iwaki Kyoritsu Hospital, Iwaki, Fukushima; Iwate Prefectural Central Hospital, Morioka, Iwate; Osaka Police Hospital, Osaka; Osaka Koseinenkin Hospital, Osaka; Ohta Memorial Hospital, Koriyama, Fukushima; Kagawa Prefectural Central Hospital, Takamatsu, Kagawa; Kagoshima City Hospital, Kagoshima; Kurashiki Central Hospital, Kurashiki, Okayama; Tenri Hospital, Tenri, Nara; Nagoya Daini Red Cross Hospital, Nagoya, Aichi; Nagaoka Red Cross Hospital, Nagaoka, Niigata; Hachinohe City Hospital, Hachinohe, Aomori; Fuku Red Cross Hospital, Fukui; Tokyo Metropolitan Fuchu Hospital, Fuchu, Tokyo; Mihara Memorial Hospital, Iseaki, Gunma; Yamagata Prefectural Central Hospital, Yamagata; Yamanashi Prefectural Central Hospital, Kofu, Yamanashi; Fukuroi Municipal Hospital, Fukuroi, Shizuoka; Koshigaya Municipal Hospital, Koshigaya, Saitama; Saiseikai Yahata General Hospital, Kitakyushu, Fukuoka; Kyoto Second Red Cross Hospital, Kyoto; Ohkawara Neurosurgical Hospital, Morigaon, Hakodate; Chugoku Rousai Hospital, Kure, Hiroshima; Nara Prefectural Nara Hospital, Nara; Matsuyama Shimin Hospital, Matsuyama, Ehime; Saiseikai Yokohamashi Nambu Hospital, Yokohama, Kanagawa; Hyogo Brain and Heart Center at Himeji, Himeji, Hyogo; St. Mary’s Hospital, Kurume, Fukuoka; Asahikawa Red Cross Hospital, Asahikawa, Hokkaido; Chiba University Hospital, Chiba, Chiba; Iwate Prefectural Hospital, Morioka, Iwate; Sasebo City General Hospital, Sasebo, Nagasaki; Okayama University Hospital, Okayama; Okayama Red Cross Hospital, Okayama; Shiga Medical Center for Adults, Moriyama, Shiga; Teine Keijinkai Hospital, Sapporo, Hokkaido; Kosei Memorial Hospital, Fujieda, Shizuoka; Toki General Hospital, Toki, Gifu; Okayama General Hospital, Iga, Mie; Asahi University Murakami Memorial Hospital, Fukuoka; Chiba Cardiovascular Center, Ichihara, Chiba; Higashiosaka City General Hospital, Higashiosaka, Osaka; Aomori City Hospital, Aomori; and Okayama East Neurosurgical Clinic, Okayama.

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Commentary

This is a second study on volume-outcome of the Japan Neurosurgical Society (JNS) by Yasunaga et al. Based on physician-reported data collected from 107 Japanese hospitals, the authors analyzed 702 patients with unruptured aneurysms surgically treated between December 2006 and April 2007 using a risk-adjusted method and reached the following conclusions: There was no significant relationship between hospital volume and complications; and higher surgeon volume (≥ 100) was associated with lower modified Rankin scale (mRS) but no significant relationship with postoperative complications. Compared with previous studies most from the United States, the study furnished some novel information: Hospital volume is not always associated with complications, in Japanese hospitals in particular. Length of stay depends not on the surgeon but on hospital volume. Surgeon volume is not associated with postoperative complications except mRS. Risk-adjusted regressive analysis is necessary in a volume-outcome study.

Some caveats in application of the information gained from the study, however, should be addressed: The study results were obtained in Japanese clinical settings that possess a well-organized hospital system with well-trained medical staff. The limitations of the study. 107 Hospitals in the study accounted for 27.7% of 386 requested hospitals, reflecting a low response rate, along with the inherent limitations from physician-reported data collection, self-reporting of outcome, and complications as noted by the authors, there might have a selective bias in the study. Despite above-mentioned limitations, the authors should be commended for their excellent work.

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