Morbidity and mortality of patients with endovascularly treated intracerebral aneurysms: does physician specialty matter?

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OBJECTIVE Endovascular treatment of cerebrovascular pathology, particularly aneurysms, is becoming more prevalent. There is a wide variety in clinical background and training of physicians who treat cerebrovascular pathology through endovascular means. The impact of clinical training background on patient outcomes is not well documented.

METHODS The authors conducted a retrospective analysis of a large national database, the University HealthSystem Consortium, that was queried in the years 2009–2013. Cases of both unruptured cerebral aneurysms and subarachnoid hemorrhage treated by endovascular obliteration were studied. Outcome measures of morbidity and mortality were evaluated according to the specialty of the treating physician.

RESULTS Elective embolization of an unruptured aneurysm was the procedure code and primary diagnosis, respectively, for 12,400 cases. Patients with at least 1 complication were reported in 799 cases (6.4%). Deaths were reported in 193 cases (1.6%). Complications and deaths were varied by specialty; the highest incidence of complications (11.1%) and deaths (3.0%) were reported by neurologists. The fewest complications were reported by neurosurgeons (5.4%; 1.4% deaths), with a higher incidence of complications reported in cases performed by neurologists (p < 0.0001 for both complications and deaths) and to a lesser degree interventional radiologists (p = 0.0093 for complications). Subarachnoid hemorrhage was the primary diagnosis and procedure for 8197 cases. At least 1 complication was reported in 2385 cases (29%) and deaths in 983 cases (12%). The number of complications and deaths varied among specialties. The highest incidence of complications (34%) and deaths (13.5%) in subarachnoid hemorrhage was in cases performed by neurologists. The fewest complications were in cases by neurosurgeons (27%), with a higher incidence of complications in cases performed by neurologists (34%, p < 0.0001), and a trend of increased complications with interventional radiologists (30%, p < 0.0676). The lowest incidence of mortality was in cases performed by neurosurgeons (11.5%), with a significantly higher incidence of mortality in cases performed by neurologists (13.5%, p = 0.0372). Mortality rates did not reach statistical significance with respect to interventional radiologists (12.1%, p = 0.4884).

CONCLUSIONS Physicians of varied training types and backgrounds use endovascular treatment of ruptured and unruptured intracerebral aneurysms. In this study there was a statistically significant finding that neurosurgically trained physicians may demonstrate improved outcomes with respect to endovascular treatment of unruptured aneurysms in this cohort. This finding warrants further investigation.

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cular techniques to treat patients with intracerebral aneurysms. Even though the endovascular techniques that these 3 types of specialists use are either identical or very similar, the pre-fellowship clinical training that each receives is quite dissimilar. This difference in training could potentially contribute to differences in patient care ideology and subsequent outcomes.

In this retrospective study, we aimed to garner a better understanding of the possible impact of physician specialty on patient outcomes after endovascular treatment. Using a large national database, we compared the complication and mortality rates for patients with unruptured intracerebral aneurysms treated electively, as well as ruptured intracerebral aneurysms presenting with subarachnoid hemorrhage, treated by 3 different types of neurointerventional specialists: neurologists, neurosurgeons, and interventional radiologists.

**Methods**

We used the University HealthSystem Consortium (UHC) database, focusing on a 4-year period (October 2009 through September 2013; Q4 2009 to Q3 2013). We noted the records of patients whose unruptured intracerebral aneurysms (primary diagnosis code 437.3, according to the WHO’s International Classification of Diseases, Ninth Revision [ICD-9]) were treated with endovascular obliteration (primary procedure, ICD-9 code 39.72) and whose ruptured intracerebral aneurysms presented with subarachnoid hemorrhage (primary diagnosis, ICD-9 code 430) and were treated with endovascular obliteration (primary procedure, ICD-9 code 39.72).

Then, according to physician specialty, we evaluated patients’ morbidity (specifically, the complication rate) and mortality. For 3 types of specialists (neurologists, neurosurgeons, and interventional radiologists), we compared outcomes based on treating physician specialty. The percentages of procedures performed by each specialty group were compared between calendar years. To compare the complication and mortality rates in our study groups, we used a 3-way chi-square test. For statistical computations, we used GraphPad Prism (version 6, GraphPad Software, Inc.).

**Results**

**Unruptured Intracerebral Aneurysms**

Elective embolization of unruptured intracerebral aneurysms was the primary procedure and diagnosis, respectively, for 12,400 patients; 799 (6.4%) had at least 1 complication, and 193 (1.6%) died. The patient complication and mortality rates varied by the specialty of their primary treating physician: neurologists had the highest complication rate (11.1%) and the highest mortality rate (3.0%). Neurosurgeons had the lowest complication rate (5.4%) and a lower mortality rate (1.4%). As compared with neurosurgeons, neurologists had a significantly higher complication rate (p < 0.0001; \( \chi^2 = 64.4 \)) as did interventional radiologists (6.6%), albeit to a lesser degree (p = 0.0093; \( \chi^2 = 6 \)). Neurosurgeons (1.4%) and interventional radiologists (1.3%) had comparable mortality rates, which were significantly less than that of neurologists (3.0%, p < 0.0001; \( \chi^2 = 17.2 \)). Complications and deaths of patients with embolization of unruptured intracerebral aneurysms based on treating physician specialty are summarized in Fig. 1.

**Subarachnoid Hemorrhage**

Endovascular obliteration of ruptured intracerebral aneurysms with subarachnoid hemorrhage was the primary procedure and diagnosis, respectively, for 8197 patients; 2385 (29%) had at least 1 complication, and 983 (12%) died. Again, the patient complication and mortality rates varied by the specialty of their physician: neurologists had the highest complication rate (34%) and the highest mortality rate (13.5%). Neurosurgeons had the lowest complication rate (27%) and the lowest mortality rate (11.5%). As compared with neurosurgeons, neurologists had a higher complication rate (p < 0.0001; \( \chi^2 = 21.6 \)), as did neuroradiologists, although this finding was not statistically significant (p < 0.0676; \( \chi^2 = 3.3 \)). The lowest incidence of mortality was noted in cases performed by neurosurgeons (11.5%), with a significantly higher incidence of mortality in cases performed by neurologists (13.5%, p = 0.0372, \( \chi^2 = 4.34 \)). Incidence of mortality was similar to that of neurosurgeons in patients treated by radiologists (12.1%, p = 0.4884, \( \chi^2 = 0.48 \)). Complications and deaths of patients treated using embolization of ruptured intracerebral aneurysms based on treating physician specialty are summarized in Fig. 2. Morbidity and mortality outcomes for unruptured and ruptured aneurysms for all specialties are summarized in Table 1.

**Treatment Volume**

A temporal trend suggests an increased volume of aneurysms are being treated by neurologists: the percentage of patients treated by neurologists in the UHC database increased by year (14% in 2009, 15% in 2010, 18% in 2011, 19% in 2012, and 21% in 2013), while there was a decreased overall percentage of patients treated by neurosurgeons (59% in 2009, 59% in 2010, 56% in 2011, 55% in 2012, and 51% in 2013). This trend is particularly pro-
nounced for patients with treated unruptured aneurysms. However, the overall number of patients treated by interventional radiologists was relatively constant. This trend is summarized in Fig. 3 upper (for unruptured aneurysms) and Fig. 3 lower (for ruptured aneurysms).

**Discussion**

Notable differences in outcomes were found in the 3 different physician specialty groups with respect to the endovascular treatment of aneurysms. For patients with ruptured intracerebral aneurysms and subarachnoid hemorrhages, neurologists had a complication rate of 34% and a mortality rate of 13.5%, whereas neurosurgeons had the lowest complication rate (27%) and the lowest mortality rate (11.5%). For patients with unruptured intracerebral aneurysms, a difference in outcomes between specialty designation was also noted: neurologists had a complication rate of 11.1% and a mortality rate of 3.0%, whereas neurosurgeons had the lowest complication rate (5.4%) and a lower mortality rate (1.4%). When compared with neurosurgeons, interventional radiologists only trended toward a slightly higher complication rate (6.6%) and comparable mortality rate (1.3%).

These findings, however, are tempered by the limitations of the UHC database. The UHC includes academic health systems from across the US, with a focus on quality, safety, and excellence (http://www.uhc.edu). The consortium consists of 120 academic medical centers with more than 300 of their affiliated hospitals, who self-report data to the UHC. Individual patient characteristics are not readily available with the current reporting structure. Given the limitations of the UHC database, it is impossible to know whether patients’ complications occurred preoperatively, intraoperatively, or postoperatively. Also, we were unable to compare preoperative morbidity of patients in our 3 physician specialty groups; the presence or absence of preoperative morbidity could represent an impactful confounding factor. We are also not able to directly compare individual centers with respect to outcome and volume or specific aneurysm morphology. Without patient-matched demographics, our data remain far from complete; nonetheless, we believe that the statistically significant differences by physician specialty that were noted warrant closer inspection and potentially merit prospective evaluation. It should also be noted that there could be significant differences in patient profiles, and subsequently a potentially disparate impact with respect to patient selection. The differences noted could also be attributed to the overall cerebrovascular volume of the treating center as well as the individual treating physician. Hoh et al. previously described the in-hospital morbidity and mortality in the endovascular treatment of intracerebral aneurysms as they pertain to physician and hospital volume. They noted hospitals with higher volumes (> 23 admissions) had better outcomes than those hospitals with lower volumes.

**TABLE 1. Morbidity and mortality rates in unruptured intracerebral aneurysms and subarachnoid hemorrhage treated by elective embolization, according to physician specialty**

<table>
<thead>
<tr>
<th>Physician Specialty</th>
<th>Unruptured Intracerebral Aneurysms (%)</th>
<th>Subarachnoid Hemorrhage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neurosurgery</td>
<td>5.4</td>
<td>27</td>
</tr>
<tr>
<td>Neurology</td>
<td>11.1</td>
<td>34</td>
</tr>
<tr>
<td>Interventional Radiology</td>
<td>6.6</td>
<td>30</td>
</tr>
</tbody>
</table>

**FIG. 2.** Bar graph illustrating morbidity and mortality rates of endovascular treatment of subarachnoid hemorrhage according to physician specialty. Asterisk indicates significant differences in complication rates (p < 0.05).

**FIG. 3.** Graphs illustrating the total percentage of treated patients with unruptured intracerebral aneurysms (upper) and ruptured aneurysms and subarachnoid hemorrhage (lower), according to physician specialty and year.
Physicians of varied specialties use endovascular treatment of ruptured and unruptured intracerebral aneurysms. In this study we found that patients treated by neurosurgeons, when compared with neurologists and to a lesser degree with interventional radiologists, had improved outcomes. Our finding of lower complication and mortality rates for the patients treated by neurosurgeons is compelling and warrants further investigation.

Conclusions

Physicians of varied specialties use endovascular treatment of ruptured and unruptured intracerebral aneurysms. In this study we found that patients treated by neurosurgeons, when compared with neurologists and to a lesser degree with interventional radiologists, had improved outcomes. Our finding of lower complication and mortality rates for the patients treated by neurosurgeons is compelling and warrants further investigation.

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References


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Author Contributions
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