Intracranial Aneurysms in Elderly Individuals: case series epidemiology

Aneurismas Intracranianos em Idosos: epidemiologia de série de casos

Leandro José Haas
Guilherme Wandall
Wesley Severino
Bernardo Przysienzny
Wallace Mees
Bruno Menegatti Sanches
Matheus Durieux Soares
Caroline Barbosa Lima
Fernanda Jacobsen Cobra

ABSTRACT

Introduction: Aneurysmal pathology is becoming increasingly prevalent in the general population, especially as life expectancy increases. Dilation of cerebral arteries in elderly patients tends to be increasingly present in neurosurgeons' routine. Therefore, the investigation of cerebral aneurysms in elderly patients is relevant to their clinical and surgical management. Objective: to establish a relationship between age and propensity to aneurysmal disease, as well as to draw up a clinical-epidemiological profile in this age group. Methods: Descriptive observational study of individuals aged 70 or older diagnosed with cerebral aneurysm who underwent endovascular treatment at the Endovascular Neurosurgery Service of the Santa Isabel Hospital between 2005 and 2023. Results: Females were the most affected (75.81%), saccular aneurysms were the most prevalent (95.81%), and their size was often small (69.76%). Endovascular treatment was the method of choice for this group of patients, with coil therapy being the most prevalent (66.97%). Conclusion: Aneurysms in the elderly had similar general characteristics to those in adult patients; however, the aging process manifested itself in certain nuances in clinical presentation, such as associated comorbidities. This topic requires further investigation in the literature, especially in patients over the age of 80, where the smaller number of individuals makes scientific analysis challenging.

Keywords: Intracranial Aneurysm; Elderly; Neurosurgery; Endovascular procedures; Subarachnoid hemorrhage
INTRODUCTION

Cerebral aneurysms are arterial dilations that occur at points of weakening of the tunica vascularis; the most common morphology is saccular, and the most prevalent site of involvement is the anterior cerebral circulation, arising from the carotid arteries. Cerebral aneurysms have been more often diagnosed due to the spread of new examination techniques and the increased accessibility of advanced imaging exams\(^1\)-\(^3\).

While reports of ruptured cerebral aneurysms have been extensively catalogued, there is no consensus on their correct management, especially in patients over 70 years of age. In addition, epidemiological data on this pathology in this age group is scarce. The few existing studies come predominantly from Japan and the USA, where life expectancies are 83.98 and 78.69, respectively, and a few of them from Nordic countries, where life expectancy is also above the world average\(^4\)-\(^5\).

In Brazil life expectancy is 75.51 years. In a few states, however, it is above 78 years and an increasingly significant percentage of the population is over 70 years old, making it necessary to review pathologies such as cerebral aneurysms, which are becoming increasingly more important as a cause of morbidity and mortality, as in the above mentioned countries\(^6\).

The scarcity of initial basic national epidemiological information on cerebral aneurysms in this age group interferes with the decision as to the most appropriate management to provide. It should also be noted that the use of epidemiological data from other countries in the Brazilian scenario is not fully adequate, since it does not take into account the variation in population genetic factors, most prevalent comorbidities and different lifestyle habits that can lead to an increase or to a decrease of the incidence of this pathology\(^1\).

With this in mind, this study aims to delve into the characteristics of aneurysms, patient comorbidities and treatments given to the elderly population, in order to gain a better clinical and epidemiological understanding of aneurysms in this population.

METHODOLOGY

This was a concurrent cohort, descriptive, observational study of individuals aged 70 or older diagnosed with ruptured or unruptured intracranial aneurysms who underwent endovascular treatment at the endovascular neurosurgery referral service of the Santa Isabel Hospital, Blumenau, state of Santa Catarina, between October 2005 and July 2023.

The variables studied were: aneurysm morphology (saccular, fusiform, mammillary), size, vascular location and integrity of the aneurysm (ruptured or unruptured), comorbidities, age, sex, type of treatment given, as well as Fischer and Hunt-Hess classification of intracerebral hemorrhage.
Patients were analyzed according to their respective imaging findings, thus assigning them a Fisher scale score, as well as according to their respective clinical manifestations, assigning them a Hunt and Hess scale score. Only patients with a score equal to or higher than Fisher scale 2 were considered to have ruptured aneurysms, thus having a Hunt and Hess scale score equal to or higher than grade 1.

Aneurysms can be classified according to their specific dimensions: small aneurysms are characterized by dimensions below 10 millimeters, whereas large aneurysms are equal to or larger than 10 mm and smaller than 20 mm, and giant aneurysms are equal to or larger than 20 millimeters.

All the procedures were carried out by a neurosurgeon specializing in neurointervention with more than 17 years’ experience and more than 2,000 angioplasties performed. The choice of the technique and of the stent was left to the discretion of the operating physician.

The project complied with current ethical standards and was approved by the local ethics committee under CAAE 36208720.7.0000.5370. The authors have no conflicts of interest and have received no funding.

RESULTS

Of the 1,903 cases of intracranial aneurysms treated at the endovascular neurosurgery service, Santa Isabel Hospital, between October 2005 and July 2023, 11.29% were aneurysms in the elderly. Of these patients, 52 were male (24.18%), with a mean age of 75.71, and 163 were female (75.81%), with a mean age of 75.39.

The overall average age of the sample of 215 cases was 75.47 (Chart 1).

As for the presence of comorbidities, systemic arterial hypertension (SAH) was the most prevalent, in 164 cases (76.27%), 26.21% (N = 43) of which in male and 73.78% (N = 121) in female patients, followed by dyslipidemia in 50.23% (N = 108), of the patients, 27.77% (N = 30) male and 72.22% (N = 78) female, and diabetes mellitus in 17.20% (N = 37) of the patients, 29.72% (N = 11) male and 70.27% (N = 26) female. A previous or current history of smoking was reported in 21.86% of the patients (N = 47), 40.42% (N = 19) of whom were male and 59.57% (N = 28) were female.

Saccular aneurysms were 95.81% of the cases (N = 206), of which 23.78% (N = 49) in male and 76.21% (N = 157) in female patients. Fusiform aneurysms were 1.86% (N = 4), 25% (N = 1) in male and 75% (N = 3) in female patients. Mammillary aneurysms were 1.39% (N = 3), 33.33% (N = 1) in female and 66.66% (N = 2) in male patients. Dissecting aneurysms were 0.46% (N = 1), 100% (N = 1) in male patients, and infundibular aneurysms were 0.46% (N = 1), 100% (N = 1) in female patients.

As for aneurysm size, 69.76% (N = 150) of the cases were small aneurysms, of which 26% (N = 39) in male and 74% (N = 111) in female patients; 20.46% (N = 44) of the cases were large aneurysms, of which 22.72% (N = 10) in male and 77.27% (N = 34) in female patients; 9.76% (N = 21) of the cases were giant aneurysms, of which 14.28% (N = 3) in male and 85.71% (N = 18) in female patients. (Table 1).

As for aneurysm topography, Table 2 shows the relationship between aneurysm location and involvement by sex, highlighting the highest prevalence – f 25.11% (N = 54) – of posterior communicating artery aneurysms, of which 20.37% (N = 41) in male and 79.62% (N = 43) in female patients (Table 2).

Chart 1. Age distribution of elderly patients with intracranial aneurysms by sex, November 2005-July 2023, Santa Isabel Hospital, Blumenau, 2023.

<table>
<thead>
<tr>
<th>Age ranges</th>
<th>Male</th>
<th>Female</th>
<th>Total number of individuals</th>
</tr>
</thead>
<tbody>
<tr>
<td>(70 – 80)</td>
<td>44</td>
<td>142</td>
<td>186</td>
</tr>
<tr>
<td>(81 – 90)</td>
<td>07</td>
<td>21</td>
<td>28</td>
</tr>
<tr>
<td>(91 – 100)</td>
<td>01</td>
<td>0</td>
<td>01</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>163</td>
<td>215</td>
</tr>
</tbody>
</table>

Source: Santa Isabel Hospital, Neurosurgery Department, 2023.
The Fisher scale scores point out that 68.83% (N = 148) of these individuals were Fisher scale 1, 25.67%, (N = 38) of whom male and 74.32%, (N = 110) female patients, as reported and complemented in Chart 2.

Based on the Hunt and Hess scale, we found that 68.83% (N = 148) of the individuals were grade 0, 25.67% (N = 38) of whom were male and 74.32% (N = 110) were female patients. The other data can be found in the chart below (Chart 3).

It was thus established that 68.83% (N = 148) were unruptured aneurysms, Fisher scale 1 and Hunt and Hess scale grade 0, 25.67% (N = 38) of which in male and 74.32% (N = 110) in female patients. So, 31.16% of aneurysms (N = 67) were ruptured, Fisher scale 2 or higher and Hunt and Hess scale 1 or higher, 20.89% (N = 14) of which in male and 79.10% (N = 53) in female patients (Chart 4).

Regarding to the treatment of intracranial aneurysms in the elderly, 100% of the sample (N = 215) underwent endovascular procedures. A stent-only approach was used in 5.11% (N = 11) of these procedures, of which 54.54% (N = 66) were performed on male and 45.46% (N = 49) on female patients. In 66.97% (N = 144) of the cases, only coils were used, 22.22% (N = 32) of which on male and 77.77% (N = 112) on female patients. In 24.18% (N = 52) of the procedures, the treatment of choice was a combination of coils and stents, 26.92% (N = 14) of which performed on male and 73.07% (N = 38) on female patients. In 2.32% (N = 5) of the cases, only flow-diverting stents were used, 100% (N = 5) on female patients. The procedures failed in 1.39% (N = 3) of the patients, 100% (N = 3) of whom were female, due to unfavorable anatomy and to the unavailability of suitable materials at the beginning of the study (Chart 5 and Table 3).
Chart 2. Fisher scale scores for elderly patients with intracranial aneurysms, according to sex, November 2005-July 2023, at Santa Isabel Hospital, Blumenau, 2023.

<table>
<thead>
<tr>
<th>Fisher scale</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fisher 1 (no blood detected in the subarachnoid space)</td>
<td>38</td>
<td>110</td>
<td>148</td>
</tr>
<tr>
<td>Fisher 2 (diffuse bleeding with vertical layers of blood less than 1 mm thick, no clots)</td>
<td>0</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Fisher 3 (localized clot and/or vertical layers of blood 1 mm or more thick, no intraventricular hemorrhage)</td>
<td>07</td>
<td>10</td>
<td>17</td>
</tr>
<tr>
<td>Fisher 4 (intraparenchymal or intraventricular clots with or without diffuse subarachnoid hemorrhage)</td>
<td>07</td>
<td>33</td>
<td>40</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>52</td>
<td>163</td>
<td>215</td>
</tr>
</tbody>
</table>

Source: Santa Isabel Hospital, Neurosurgery Department, 2023.

Chart 3. Hunt and Hess scores for elderly patients with intracranial aneurysms, according to sex, November 2005-2023, at Santa Isabel Hospital, Blumenau, 2023.

<table>
<thead>
<tr>
<th>Hunt and Hess scale</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 0 (unruptured aneurysm)</td>
<td>38</td>
<td>110</td>
<td>148</td>
</tr>
<tr>
<td>Grade 1 (asymptomatic or minimum headache and nuchal rigidity)</td>
<td>01</td>
<td>01</td>
<td>02</td>
</tr>
<tr>
<td>Grade 2 (moderate-to-severe headache, nuchal rigidity, no neurological deficits except for cranial nerve palsy)</td>
<td>06</td>
<td>21</td>
<td>27</td>
</tr>
<tr>
<td>Grade 3 (drowsiness, confusion, moderate focal deficit)</td>
<td>03</td>
<td>18</td>
<td>21</td>
</tr>
<tr>
<td>Grade 4 (stupor, moderate-to-severe hemiparesis, early decerebrate rigidity, vegetative disorders)</td>
<td>02</td>
<td>09</td>
<td>11</td>
</tr>
<tr>
<td>Grade 5 (deep coma, decerebrate rigidity, moribund appearance)</td>
<td>02</td>
<td>04</td>
<td>06</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>52</td>
<td>163</td>
<td>215</td>
</tr>
</tbody>
</table>

Source: Santa Isabel Hospital, Neurosurgery Department, 2023.

Chart 4. Intracranial aneurysm integrity in elderly patients, according to sex, November 2005-July 2023, Santa Isabel Hospital, Blumenau, 2023.

<table>
<thead>
<tr>
<th>Aneurysm integrity</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unruptured aneurysms (Fisher scale = 1, Hunt and Hess scale = 0)</td>
<td>38</td>
<td>110</td>
<td>148</td>
</tr>
<tr>
<td>Ruptured aneurysms (Fisher scale ≥ 2, Hunt and Hess scale ≥ 1)</td>
<td>14</td>
<td>53</td>
<td>67</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>52</td>
<td>163</td>
<td>215</td>
</tr>
</tbody>
</table>

Source: Santa Isabel Hospital, Neurosurgery Department, 2023.

Chart 5. Endovascular treatments in elderly patients with intracranial aneurysms, according to sex, November 2005-July 2023, at Santa Isabel Hospital, Blumenau, 2023.

<table>
<thead>
<tr>
<th>Endovascular treatments</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only Stents</td>
<td>06</td>
<td>05</td>
<td>11</td>
</tr>
<tr>
<td>Only Coils</td>
<td>32</td>
<td>112</td>
<td>144</td>
</tr>
<tr>
<td>Stents with Coils</td>
<td>14</td>
<td>38</td>
<td>52</td>
</tr>
<tr>
<td>Only flow-diverting stent</td>
<td>0</td>
<td>05</td>
<td>05</td>
</tr>
<tr>
<td>Failure</td>
<td>0</td>
<td>03</td>
<td>03</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>52</td>
<td>163</td>
<td>215</td>
</tr>
</tbody>
</table>

Source: Santa Isabel Hospital, Neurosurgery Department, 2023.
DISCUSSION

When we look at the entire universe of cerebral aneurysms, it is clear that there is a patient profile that is more predisposed to developing this arterial problem, with females between the ages of 35 and 60 accounting for the largest number of cerebral aneurysms. This consideration leads us to believe that hormonal interference may be associated with the higher number of women with aneurysms\textsuperscript{1,2}.

Initially, the group of patients aged 70-80 was clearly the largest, making up over 80% of the patients registered in this study, followed by the groups aged 81-90 and then over 90. The two last groups included considerably fewer patients. As for an increase in the incidence of aneurysms with advancing patient age, there is no definitive data on the number of patients in each group. However, an analysis of autopsies conducted in 1999 by the Hisayama study group showed an increase in the incidence of aneurysms with advancing age. However, in a systematic review and meta-analysis carried out by Vlak et al. in 2011, there was no association between age and an increase in the incidence of aneurysms\textsuperscript{5,7}. Now, moving on to the main nuances found in aneurysms in patients over 70, we found that just over 75% of all 215 patients registered in this study were female.

The comorbidities most classically associated with cerebral aneurysms as etiological and morbidity and mortality factors are hypertension and smoking/history of smoking, with risk factors which, on their own, can substantially impair the clinical history of patients with cerebral aneurysms. Their association, however, increases the risk of subarachnoid hemorrhage due to aneurysm rupture by up to 15 times. Other factors, such as a family history of aneurysms and collagen diseases, are also known to be associated with aneurysms\textsuperscript{1-3}. As expected, systemic arterial hypertension was highly prevalent in all groups, with 76.27% (N=164) of the patients having this previous comorbidity. For smoking, on the other hand, the results were not as we expected, being higher only than that for diabetes mellitus. Smoking patients were a small proportion of the elderly population, 21.86% (N=47). Dyslipidemia had a surprisingly high level of incidence, being the second most common comorbidity in these patients (second only to hypertension), with just over half of all patients having this lipid imbalance.

The average size of cerebral aneurysms ranged from 2 to 7 mm\textsuperscript{6}, which is 62% of the total sample, followed by aneurysms of 7 to 12 mm with a 23% sample incidence. In a different study, the majority of cerebral aneurysms were between 7 and 12 mm (86.5%)\textsuperscript{8}, but 71% were between 3 and 4.9 mm. Vlak et al.\textsuperscript{7} also showed that most of the sample in their meta-analysis had aneurysms of less than 5 mm. When it comes specifically to the elderly, Hishikawa’s study showed that aneurysms smaller than 5 mm were still the most frequently found ones even in this age group, but in a different proportion relative to the younger population, with 37.7% of the aneurysms found being 3-4 mm, 25.4% 5-6 mm and 20.7% 7-9 mm, i.e. there was a significant increase in the incidence of larger aneurysms in this population, but the small ones continued to be the most common ones\textsuperscript{9}. The distribution was similar to that in Hishikawa’s study in relation to Inagawa’s study, which showed an even higher prevalence of larger aneurysms, with 20% for aneurysms measuring 10-14 mm\textsuperscript{10}. However, there is controversy, since studies such as Lanzino’s and Sedat’s, from 1996 and 2005, respectively, found no association between age and aneurysm size\textsuperscript{9,15}.

During the course of this study, aneurysm sizes were clearly consistent with the findings of the authors cited below, small aneurysms remaining the main size observed in the entire universe of patients; however, with the advancing age of the typical patient, the larger sizes of cerebral aneurysms become more and more prevalent. The most consistent example was that large aneurysms were found in approximately 20% of all patients, which coincides with Hishikawa’s data\textsuperscript{9}.

As for the types of cerebral aneurysm conformation, there is already a consensus regarding the high prevalence of saccular aneurysms over the other conformations, demonstrating that the history of the typical patient tends to be almost dominated by saccular aneurysms\textsuperscript{1-3}. The empirical results based on the elderly population tend to further highlight this claim, since more than 95% of aneurysm patients over 70 are diagnosed with saccular aneurysms; the other conformations, such as fusiform and mammillary, for example, account for only 1.86% (N=4) and 1.39% (N=3) of these cases, respectively. The prevalence of female patients was noticeable in all the other conformations, with an average incidence of 72.62%.

As for the most common locations of aneurysms, in young patients, we have the descending order as follows: middle cerebral artery, internal carotid artery, and posterior communicating artery\textsuperscript{5,7,8}. In elderly patients, the vast majority of studies have shown the same sites as in younger patients\textsuperscript{5,8,11}, with the exception of a study by Sakaki et al.\textsuperscript{11}, which showed a slightly higher incidence of

\textsuperscript{1} Haas LJ, Wandall G, Severino W, Przysienzny B, Mees W, Sanches BM, Soares MD, Lima CB, Cobra FJ - Intracranial Aneurysms in Elderly Individuals: case series epidemiology

\textsuperscript{2} https://doi.org/10.22290/jbnc.2023.340401
aneurysms in the vertebrobasilar territory. In our study, the site
with the highest incidence was the posterior communicating artery,
accounting for just over ¼ of cases in patients over 70 years old.

Using the Fisher scale, the most common type was Fisher 1,
accounting for 68.83% (N=148) of the total range of patients. After a
rupture, patients are Fisher 4, the second largest group in this study,
but they are still 18.6% (N=40), significantly less than Fisher 1.

Proceeding with the Hunt and Hess scale, 68.83% (N=148) of all
patients were grade 0. Curiously enough, grade 1 was the only score
with an even distribution of male and female patients. The other
grades, from 2 to 5, followed a decreasing sequence of prevalence,
with female patients always predominating in all of them.

These aneurysms are currently treated with either microsurgical
clipping or endovascular techniques. The nuances regarding
the advantages of each technique were highlighted by different
studies in order to establish which one is the best. Several studies
comparing the treatment routes were already carried out and what
has been established so far is that both alternatives are effective
and the choice of the type of procedure depends mainly on the
area of expertise of the service in question.

According to the results of this study, coil therapy was the dominant
treatment, with an overall prevalence of 66.97% (N=144) for
ruptured aneurysms, followed by stents in association with coils,
with 24.18% (N=52) for unruptured aneurysms. The two major
forms of treatment were most commonly used on female patients.

With regard to morbidity and mortality, we found that patients
with ruptured cerebral aneurysms, who scored 4 on the Fisher
scale and 4 and 5 on the Hunt Hess scale, had a worse outcome.
Patients with unruptured aneurysms, on the other hand, had a
complication rate of 2%, with embolic effects and hematomas
at the puncture site being the main complications.

CONCLUSION

In general, for this type of patient, the epidemiology did not
deviate too much from a typical patient affected by cerebral
aneurysm. The total scope of the data leads to the conclusion
that the most typical patient who develops a cerebral aneurysm
in old age would be a woman with a history of systemic arterial
hypertension and dyslipidemia. The most common conformation
and size was consistent with the typical history of aneurysmal
disease, i.e. the most likely aneurysm would be saccular and
small. The topography was perhaps the most unique feature in
the study, with the posterior communicating artery being the site
of most cases of arterial dilation. The most commonly used
endovascular treatment in patients over 70 was coil therapy, used
in over 60% of all cases.

Inherent in the ageing process, sarcopenia is one of the many
aggravating factors of aneurysmal disease, which means that
the elderly population requires more attention in terms of their
medical care than the general adult patient population. However,
epidemiological observation of cerebral aneurysms in patients
over the age of 70 is seldom found in the current literature.

REFERENCES

aneurysms: natural history, clinical outcome, and risks of surgical and
or/10.1016/S0140-6736(03)13860-3. PMid:12867109.
In: Smith RR, Zubkov YN, Tarassoli Y, editors. Cerebral Aneurysms.
4613-9532-4_1.
5. Hishikawa T, Date I. Unruptured cerebral aneurysms in elderly
or/10.2176/nmc.ra.2016-0286. PMid:28428448.
saccular aneurysms in a Japanese community based on a consecutive
autopsy series during a 30-year observation period: the Hisayama study.
PMid:10390312.


CORRESPONDING AUTHOR

Leandro José Haas, MD, PhD
Medical School, Regional University of Blumenau
Endovascular Neurosurgery
Santa Isabel Hospital
Blumenau, Santa Catarina, Brazil
Email: ljhaas@terra.com.br

Funding: nothing to disclose
Conflicts of interest: nothing to disclose
Ethics Committee Approval: CAAE 36208720.7.0000.5370