Outcomes of chronic subdural hematoma drainage in nonagenarians and centenarians: a multicenter study

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OBJECTIVE Chronic subdural hemorrhage (SDH) or hematoma is a condition that affects elderly individuals. With advances in medical care, the number of nonagenarians and centenarians will increase. However, surgical treatments in this age group are associated with high rates of morbidity and mortality. Because no data are available on the rates of survival among elderly patients with chronic SDHs who undergo surgical drainage or receive only conservative care, the goal of this study was to determine survival rates in patients 90 years of age or older with symptomatic chronic SDHs.

METHODS The authors conducted a retrospective analysis of patient data that were collected at 3 hospitals over a 13-year period (from January 2001 to June 2013). The data from patients 90 years or older with symptomatic chronic SDHs and who were offered surgical treatment were included in the analysis. Patients who underwent surgical treatment were included in the surgical group and patients who declined an operation were included in the conservative care group. The patients’ Charlson Comorbidity Index score, Karnofsky Performance Scale score, dates of death, presenting symptoms, Glasgow Coma Scale score, length of stay in the hospital, discharge location, side of the SDH, and neurological improvements at 30-day and 6-month follow-ups were recorded. Data were statistically analyzed with Fisher exact test, Kaplan-Meier curves, and logistic regression.

RESULTS In total, 101 patients met the inclusion criteria of this study; 70 of these patients underwent surgical drainage, and 31 received conservative care. Patients in the surgical group had statistically significantly (p < 0.001) higher survival at both the 30-day and 6-month follow-ups, with 92.9% and 81.4% of the patients in this group surviving for at least 30 days and 6 months, respectively, versus 58.1% and 41.9%, respectively, in the conservative care group. Moreover, the mean overall length of survival of 34.4 ± 28.7 months was longer in the surgical group than it was in the conservative care group (11.3 ± 16.6 months). Overall, 95.7% of patients in the surgical group exhibited an improvement in neurological status after the SDH drainage, whereas none of the patients in the conservative care group showed any neurological improvement during their hospital stay. The surgical complication rate was 11.4%, and the overall rate of chronic SDH recurrence after surgery was 12.9%.

CONCLUSIONS Surgical drainage of chronic SDHs in nonagenarians and centenarians is associated with lower incidence of inpatient death and higher 30-day and 6-month survival rates.


KEY WORDS chronic subdural hemorrhage; hematoma; nonagenarians; centenarians; surgical drainage; trauma

“...to drain, or not to drain, that is the question.” Chronic subdural hemorrhage (SDH) or hematoma is a predominantly neurological condition usually resulting from trauma and affecting elderly individuals. Chronic SDH is not a benign condition and is regarded as a sentinel health event because of its high morbidity and mortality rates in older people. The treatment of choice for managing chronic SDHs is surgical drainage. Large studies have shown that older age independently contributes to increased mortality and morbidity rates after the surgical drainage of chronic SDHs. As the world’s elderly population increases because of ad-

ABBREVIATIONS CCI = Charlson Comorbidity Index; GCS = Glasgow Coma Scale; KPS = Karnofsky Performance Scale; LOS = length of stay; SDH = subdural hematoma.


INCLUDE WHEN CITING Published online July 10, 2015; DOI: 10.3171/2014.12.JNS142053.

DISCLOSURE The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.
vances in medical care, the question of whether to drain the chronic SDHs of the “oldest elderly people” (nonagenarians and centenarians) becomes more pertinent.

In the United States alone, the number of elderly individuals 90 years or older has more than doubled recently, from 720,000 in 1980 to 1.5 million in 2010. With the expected surge in this age group in the coming years, health care providers will need to care for an increasing number of older patients. Surgical treatment of this patient demographic has always been very controversial, and neurosurgical data after drainage of chronic SDH in nonagenarians are extremely scarce. Only one previous study has shown no difference in outcome between surgical drainage and conservative care. Long-term outcomes had very low success rates in both groups, with only 24% of the patients returning home despite initially having a favorable presenting Glasgow Coma Scale (GCS) score.

In the 1990s, studies showed that perioperative mortality rates associated with surgery in patients ≥ 90 years of age are as high as 20%. Physicians have therefore treated elderly patients more conservatively. With recent advances in perioperative and postoperative care, morbidity and mortality rates have generally decreased, and surgical treatment may be associated with more acceptable outcomes also in nonagenarians and centenarians.

These evolving results present challenges for the surgeon in deciding whether to surgically drain chronic SDHs or to manage them conservatively in elderly patients. We performed a retrospective study to compare the survival outcomes between surgical drainage and conservative management of chronic SDHs in nonagenarians and centenarians.

Methods
Study Design

We conducted an institutional review board–approved study to determine whether drainage of chronic SDHs in nonagenarians and centenarians increased rates of survival among these patients. For patients who underwent surgical drainage, we also wanted to determine whether any additional factors may have contributed to postoperative complications. Patients were from 3 hospitals in Singapore: Singapore General Hospital, Changi General Hospital, and Tan Tock Seng Hospital. All patients in the study were followed up for at least 6 months. We reviewed the patients’ records in electronic databases, operative notes, CT scans, and case notes.

The medical records from all patients admitted over a 13-year period from January 2001 to June 2013 were screened to identify those patients who were ≥ 90 years old and whose records contained an International Classification of Disease, Ninth Revision (ICD-9) diagnosis code for SDH (that is, Code 432.1) in the electronic databases of participating hospitals. The CT brain scans from patients identified as having an SDH were reviewed to determine whether the SDH was acute or chronic and to measure the size of any chronic SDHs. The electronic medical notes were then reviewed to determine whether a patient had shown symptoms of the chronic SDH and whether he or she had been offered surgical drainage. Only patients who were ≥ 90 years old, who had a symptomatic chronic SDH, and who were offered surgical treatment were included in this study.

The selected patients’ symptoms at presentation included limb weakness, drowsiness, and confusion. Patients who underwent surgical drainage of their chronic SDH composed the surgical group and patients who declined to undergo an operation made up the conservative care group. The latter patients were offered but did not undergo surgical treatment either because they did not consent to it or because their families did not consent on their behalf if they themselves were not able to give consent.

The patients’ age, sex, age-adjusted Charlson Comorbidity Index (CCI) score, and Karnofsky Performance Scale (KPS) score were recorded and used to check whether the 2 patient groups were similar in these variables. If a patient was deceased during the study period, the date of death was obtained from the Registry of Deaths in the Immigration and Checkpoints Authority (Singapore) via the National Records of Diseases. Patients who were still alive at the time of study conclusion had their length of survival assessed to January 2014, the month the study period ended. These dates were used to calculate 30-day, 6-month, and overall survival rates. Details of the patients’ inpatient stay included their initial presenting symptoms; presenting GCS score; side of the chronic SDH; length of stay (LOS) in the hospital; discharge location, that is, either a patient’s original home, a community hospital, a rehabilitation center, or a nursing home; and death during the stay.

Any neurological improvement in the surgical and conservative care groups was recorded. This improvement was defined as an increase by at least 1 score in the power grading of the limb on the affected side according to the Medical Research Council’s scale for muscle power or an increase in a patient’s mental status according to the GCS. For the patients in the surgical group, we performed a logistic regression to identify variables that significantly contributed to postoperative complications and recurrence of chronic SDHs. Additional variables analyzed included the preoperative GCS score, type of anesthesia given, number of bur holes used, time in the operating room, presence of intraoperative brain expansion after drainage of the chronic SDH, and type of drainage used if any.

Statistical Analysis

Statistical analysis was conducted with SPSS (version 21.0). The Fisher exact test was used to compare discontinuous variables to determine statistical significance of any differences. A p value of < 0.05 was considered statistically significant. Direct logistic regression was performed to assess the impact of the measured variables on postoperative surgical complications and on recurrence of a chronic SDH. Kaplan-Meier curves were used to plot 30-day and 6-month survivals in the surgical and conservative care groups.

Results
Patient Profiles

Our survey of the 3 local hospitals’ electronic data-
bases identified 104 patients who had large, symptomatic, and chronic SDHs. Three patients were excluded from further analysis because they had severe pneumonia and were therefore not eligible for surgery, resulting in 101 patients whose data were included in our study. Seventy patients underwent surgical drainage of their chronic SDHs and were therefore included in the surgical group, and 31 patients were offered but declined surgical treatment and therefore composed the conservative care group. The demographic and clinical data of all patients are summarized in Table 1. The mean age of patients was 92 ± 3 years in the surgical group and 93 ± 2 years in the conservative care group. The 2 groups were well matched in the CCI and KPS scores: the mean age-adjusted CCI scores were 6.6 ± 1.6 and 7.0 ± 2.0 and the KPS scores were 60 ± 15 and 60 ± 16 in the surgical and conservative care groups, respectively.

Inpatient Results

Patients in the surgical group had a longer mean hospital LOS of 16.9 ± 13.2 days than those in the conservative care group whose mean LOS was 12.8 ± 7.8 days (Table 1). Patients in the surgical group had an inpatient mortality rate of 7.1% (n = 5), which was significantly lower than patients in the conservative care group, whose inpatient mortality rate was 35.5% (n = 11) (p = 0.0007). The number of patients who were discharged directly home was also significantly larger (p = 0.0303) in the surgical group, with 65.7% of patients being discharged home versus 41.9% in the conservative care group (Table 1). In the surgical group, 8 patients (11.5%) were discharged to community hospitals and 11 (15.7%) were discharged to nursing homes versus 2 patients (6.5%) and 5 patients (16.1%) in the conservative care group, respectively.

Surgical Outcomes

Of the patients in the surgical group, 67 (95.7%) exhibited an improvement in neurological status after undergoing drainage of their chronic SDH. No improvements in neurological function were observed among the patients in the conservative care group during their inpatient stay. The overall complication rate in the surgical group was 11.4%; the complications observed included seizures, wound infections, acute SDH, postoperative intraparenchymal bleeding, ischemic stroke, and acute bleeding after subdural drain removal, with incidences of between 1.4% and 2.9% (Table 2). Two patients had postoperative bleeding (that is, acute subdural and intraparenchymal bleeding) and died while in the hospital, whereas 6 other patients with complications all survived for >30 days. The perioperative mortality rate was 2.9%, and it accounted for 25% of the complications in our surgical group. A chronic SDH recurred in 9 of the surgical patients, corresponding to an overall recurrence rate of 12.9%. Six of these recurrences (66.7%) were managed conservatively because they were not large enough to be symptomatic, and those in the other 3 patients (33.3%) were treated with repeat drainage. All of the patients who underwent a repeated drainage operation survived for more than 1 year.

Logistic regression indicated that a higher age-adjusted CCI score and the use of a subdural drainage after surgery were both significantly associated with complications (p = 0.04 and p = 0.037, respectively). The use of either general or local anesthetic during the operation did not affect the rate of complications. The logistic regression also showed that poor brain expansion during the operation was significantly associated with recurrence of the chronic SDH (p = 0.001).

Survival Outcomes After 30 Days and 6 Months

The 30-day mortality rate in the surgical group was significantly lower than that in the conservative care group (p = 0.0002), with 65 surgically treated patients (92.9%) surviving past 30 days versus 18 (58.1%) in the conservative care group (Table 1 and Fig. 1). The 6-month survival rate was also significantly higher in the surgical group than in the conservative care group (p = 0.0001), with 57 (81.4%) of the patients still being alive at the 6-month follow-up in the surgical group versus 13 (41.9%) in the conservative care group (Table 1 and Fig. 2). The overall length of

<table>
<thead>
<tr>
<th>Variable</th>
<th>Treatment Group</th>
<th></th>
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<tbody>
<tr>
<td>Age in yrs</td>
<td>92 ± 3 (90–102)</td>
<td>93 ± 2 (90–98)</td>
</tr>
<tr>
<td>Sex, F/M ratio (%)</td>
<td>29/41 (42/58)</td>
<td>17/14 (55/45)</td>
</tr>
<tr>
<td>Age-adjusted CCI score</td>
<td>6.6 ± 1.6 (5–13)</td>
<td>7.0 ± 2.0 (5–13)</td>
</tr>
<tr>
<td>KPS score</td>
<td>60 ± 15 (40–90)</td>
<td>60 ± 16 (40–90)</td>
</tr>
<tr>
<td>LOS in days</td>
<td>16.9 ± 13.2 (4–62)</td>
<td>12.8 ± 7.8 (3–41)</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Discharge location, no. of pts (%)</th>
<th>Home</th>
<th>Rehabilitation/community hospital</th>
<th>Nursing home</th>
<th>Death in hospital</th>
<th>Survival, % (no. of pts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 days</td>
<td>92.9 (65/70)</td>
<td>58.1 (18/31)</td>
<td>61.3 (47/76)</td>
<td>41.9 (13/31)</td>
<td>6 mos</td>
</tr>
<tr>
<td>Overall length of survival in mos</td>
<td>34.4 ± 28.7 (0–120)</td>
<td>11.3 ± 16.6 (0–63)</td>
<td></td>
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Pts = patients.

* Values represent the mean ± SD (range), unless indicated otherwise.

TABLE 1. Demographic and clinical data of the patients in this study

<table>
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<tr>
<th>Complications</th>
<th>No. of Patients</th>
<th>Incidence (%)</th>
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</thead>
<tbody>
<tr>
<td>All</td>
<td>8</td>
<td>11.4</td>
</tr>
<tr>
<td>Seizure</td>
<td>2</td>
<td>2.9</td>
</tr>
<tr>
<td>Wound infection</td>
<td>2</td>
<td>2.9</td>
</tr>
<tr>
<td>Acute SDH</td>
<td>1</td>
<td>1.4</td>
</tr>
<tr>
<td>Postop intraparenchymal hemorrhage</td>
<td>1</td>
<td>1.4</td>
</tr>
<tr>
<td>Ischemic stroke</td>
<td>1</td>
<td>1.4</td>
</tr>
<tr>
<td>Bleeding after drainage removal</td>
<td>1</td>
<td>1.4</td>
</tr>
</tbody>
</table>

TABLE 2. Complications associated with bur hole drainage of chronic SDHs in this study
outcomes of chronic subdural hematoma drainage

Survival was also longer in the surgical group, with a mean length of survival of $34.4 \pm 28.7$ months in the surgical group versus $11.3 \pm 16.6$ months in the conservative care group (Table 1).

**Discussion**

**An Aging Population**

Because of more advanced and better medical care, the number of elderly people is increasing worldwide. In a 2011 report from the US Census Bureau commissioned by the US National Institute on Aging, the number of people 90 years or older living in the United States more than doubled in the most recent 30-year period, from 720,000 in 1980 to 1.5 million in 2010. The number of centenarians is also increasing, and currently there may be > 100,000 worldwide. Given the steady increase in the elderly population, diseases associated with old age will become more common. Previous studies have shown that increasing age directly results in higher morbidity rates with poorer functional and cognitive outcomes. Many neurosurgeons have therefore not adopted an aggressive surgical treatment in elderly patients, as they consider such efforts to be futile.

More recent studies have shown that people ≥ 90 years may have better cognitive function than previously assumed. A Danish study of 2 cohorts of nonagenarians born 10 years apart showed that the nonagenarians born in the later cohort scored higher in activities of daily living and cognitive tests, suggesting that the later generation of nonagenarians has lived to an older age with better overall functioning. The findings in this study were also consistent with those of the Rotterdam group that reported a plateau in the incidence of dementia among those ≥ 90 years. Neurosurgical data have also shown that operating on the elderly may result in favorable outcomes. Surgical techniques and postoperative care have also recently improved, which may influence the survival outcomes for elderly patients undergoing surgery.

**Survival Outcomes**

There is a paucity of data on the long-term survival outcomes of elderly patients with chronic SDH. The term “elderly” has been loosely defined, with various authors applying it to those in the different age strata 65 years or older. Surgical drainage is the treatment of choice for patients with chronic SDH, but in patients ≥ 90 years, such drainage may not be beneficial, as patients in this age group have very high morbidity and mortality rates due to preexisting illnesses and old age. Inpatient mortality rates of chronic SDHs are high, irrespective of whether these hemorrhages are drained or not.

The results of our study indicate that elderly patients who are 90 years or older benefit from surgical drainage of a chronic SDH. The differences between our 2 treatment groups were very pronounced at the 30-day follow-up, with mortality rates of 7.1% and 41.9% in the surgical and conservative care groups, respectively. Despite a longer hospital LOS for the patients who underwent surgical drainage of 16.9 days versus 12.8 days in the conservative care group, those who underwent surgery had a lower inpatient mortality rate and a larger proportion of them were discharged directly to their home or to a community hospital for further rehabilitation. This suggests that early inpatient treatment for symptomatic chronic SDHs is important, also highlighted by the observation that the conditions of 35.5% of patients in the conservative care group deteriorated and led to death during their hospital stay.

One reason for the longer LOS of patients who underwent surgical drainage was that because their neurological status had improved after this procedure, they underwent inpatient physiotherapy and rehabilitation. In elderly patients whose brain has atrophied, only larger chronic SDHs produce symptoms, making it less likely that the SDH resolves with conservative management alone. An enlarged chronic SDH will result in a larger mass effect, causing patients to be more drowsy and obtunded. Such patients then become progressively more bedbound and dependent. This makes them more susceptible to pneumonia, bedsores, and urinary tract infections, which may eventually cause their death. Therefore, the 6-month mortality rate in the conservative care group was higher than in the surgical group, even if these patients could be discharged.
To ensure that our survival data were accurate, we obtained the dates of patient deaths from the Singapore National Registry of Births and Deaths so that all inpatient as well as out-of-hospital deaths were accounted for. This allowed us to accurately track the long-term survival of patients with chronic SDHs, information which is lacking in the literature. Some of our patients survived for many years after their initial hospital stay and were able to continue to lead healthy lives. The overall survival of patients in the surgical group was higher than that of patients in the conservative group. Although several studies have shown an increase in mortality rates associated with drainage of chronic SDHs in elderly patients, the results of our study have shown that surgical drainage is associated with a long-term overall survival benefit even in patients aged over 90 years old.

Surgical Drainage of Chronic SDHs

Many surgical methods are available to drain a chronic SDH, with craniotomy, bur hole craniostomy, and twist-drill craniostomy being the approaches that are most commonly reported in the literature. Similar to the approaches used in studies from Canada, the United Kingdom, and Ireland, our preferred technique for surgical drainage is the use of bur holes. All of the patients from the 3 hospitals in our study underwent drainage of their chronic SDHs through either 1 or 2 bur holes, depending on the location of the hematoma, the time needed to complete the operation, and the surgeon’s preference. This method is as effective as a craniotomy and as safe as twist-drill craniostomy. We were fairly aggressive at draining chronic SDHs—we even operated on patients with KPS scores as low as 13, which both suggested that these patients had poor functional ability and health.

Our complication rate was 11.4%, and acute bleeding, wound infection, seizures, and ischemic strokes were the most common complications observed. Logistic regression showed that a higher age-adjusted CCI score and poorer premorbid conditions as well as the use of subdural drainage were factors that increased the risk for higher morbidity rates. Two out of the 8 surgical patients who had complications died while still in the hospital, accounting for only 25% of the complications observed and leading to an overall postoperative mortality rate of 2.9%. This postoperative mortality rate is comparable to those reported in other studies with younger patients whose postoperative mortality rates ranged from 1.6% to 11.2%. We attribute this relatively low mortality rate in our extremely elderly patients to their easy access to postoperative high-dependency and intensive care unit beds in our hospitals. This allowed us to neurologically monitor our patients closely and to aggressively correct and normalize physiological and biochemical parameters postoperatively. Some of our patients underwent local anesthesia instead of general anesthesia, and we note that these 2 regimens did not result in statistically significant differences in mortality or morbidity rates. This observation suggests that despite its higher perceived risks, general anesthesia is suitable in patients ≥ 90 years.

The rate of recurrence for surgically drained chronic SDH ranges from 3.1% to 30%. Our observed recurrence rate of 12.9% after surgical drainage was therefore comparable to these previously reported rates. In our logistic regression analysis, we found that poor brain expansion intraoperatively was a significant predictor of chronic SDH recurrence. The resolution of a chronic SDH depends greatly on the extent of cerebral reexpansion. Most of the recurrences in our cohort were asymptomatic and were diagnosed on repeat CT brain scans during outpatient follow-ups, and we noted that the recurring SDH had a larger size than the postoperative residual chronic SDH. In 6 patients, the SDH recurrence was asymptomatic, and only 3 patients required an operation for redrainage of their recurrent chronic SDH.

Conclusions

With the advent of better health care, people are living much longer than before. The world’s population of nonagenarians and centenarians will therefore increase and will require better care. Surgical drainage is the gold standard for treating chronic SDH, but it was assumed to be associated with much higher morbidity and mortality rates in patients ≥ 90 years because of their advanced age. The results of our study have shown that surgical drainage of a chronic SDH in nonagenarians and centenarians is possible and is associated with a lower incidence of inpatient death and higher 30-day and 6-month survival rates than for patients who receive only conservative care. We conclude that even in the “eldest elderly,” and despite their advanced age, it is still beneficial and safe to surgically treat a chronic SDH.

References


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Author Contributions

Conception and design: Lee, WH Ng. Acquisition of data: Lee, Ker, HY Ng, Munusamy, Kon Kam King. Analysis and interpretation of data: Lee, Ker, HY Ng, Kon Kam King. Drafting the article: Lee, Ker, Munusamy, WH Ng. Critically revising the article: Lee, Ker, HY Ng, Kumar, WH Ng. Reviewed submitted version of manuscript: Lee, Ker, Kumar. Approved the final version of the manuscript on behalf of all authors: Lee. Statistical analysis: Lee, Kon Kam King. Study supervision: WH Ng.

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