Comparative study of traumatic and spontaneous intracerebral hemorrhage


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Object. Spontaneous intracerebral hemorrhage (SICH) and traumatic intracerebral hemorrhage (TICH) are common disorders. The authors planned to study how these two types of hemorrhage behave pathologically and clinically to gain further insight into their causes, pathogeneses, indications for surgical intervention, and prognoses.

Methods. Prospectively filled databases of demographic, clinical, radiological, and outcome details have been maintained for all patients admitted to the Regional Neurosciences Centre with head injury since 1987 and with SICH since 1993. Of the 5686 patients whose case information was included in the head-injury database, 90 were found to suffer from an isolated intracerebral hemorrhage (ICH) as the only major abnormality observed on computerized tomography scans (subdural and extradural hematomas were excluded). Case details on these 90 patients and the 440 patients from the SICH database were extracted and analyzed using a statistical software program.

The median age of patients with TICH was lower than the median age of patients with SICH (51 years compared with 65 years, respectively), but it was much higher than the median age of the entire head-injury group (21 years). Among patients younger than 45 years of age, 0.8% of patients who experienced trauma suffered from an ICH compared with 4.3% of patients older than 45 years of age. Irrespective of intervention, much better outcomes were achieved by patients with TICH compared with those with SICH (67% favorable outcomes compared with 24% in patients with SICH). Following trauma, there was no significant relationship between the severity of injury and the development of ICH. At presentation the median Glasgow Coma Scale (GCS) score for both groups was 13. Younger age and higher GCS score at presentation were strongly related to a favorable outcome for both types of hemorrhage. There was no significant difference in patient age, presenting GCS score, or outcomes of patients who underwent surgery compared with those who did not for either type of hemorrhage. No conclusions can be drawn about the efficacy of surgery from such observational studies.

Conclusions. On the basis of these data the authors suggest that TICH and SICH have different features: TICH affects a slightly younger age group and carries a much better prognosis compared with SICH. In addition, indications for surgical intervention are not well defined for either type of hemorrhage. Practice is subjective and inconsistent. The International Surgical Trial in Intracerebral Haemorrhage may resolve the dilemma for SICH. A similar trial in which surgery is compared with conservative management should be considered for cases of TICH.

KEY WORDS • intracerebral hemorrhage • trauma • clinical trial

Traumatic ICH occurs in up to 15% of patients following head injury and SICH accounts for up to 44% of all strokes. These two disorders are very common. Gross examination of the morbid anatomy yields similar findings for the two conditions, but they may differ in pathogenesis, clinical behavior, and outcome. Spontaneous ICH and TICH have been discussed in the literature as separate clinical entities (albeit TICH much less frequently). There is little information on the comparative behavior of TICH and SICH. We conducted this study to compare the clinicopathological characteristics and prognoses in patients with SICH and those with TICH. Another objective of the study was to evaluate the pattern of indications for surgical intervention.

Abbreviations used in this paper: CT = computerized tomography; GCS = Glasgow Coma Scale; GOS = Glasgow Outcome Scale; ICH = intracerebral hemorrhage; SICH = spontaneous ICH; STICH = Surgical Trial in Intracerebral Haemorrhage; TICH = traumatic ICH.

Clinical Material and Methods

Starting in 1987, data obtained in all patients with head injury who presented to the Regional Neurosciences Centre at Newcastle General Hospital were recorded prospectively. In 1993, a separate database was initiated for patients who presented with SICH. Patients with ICH due to tumor, trauma, or an underlying aneurysm or arteriovenous malformation were not included in the latter database. Demographic, clinical, radiological and outcome details were included. Patients were followed for 6 months and their outcomes based on the GOS at 6 months were recorded. Patient outcomes were combined into two categories, favorable (good recovery and moderate disability) and unfavorable (severe disability, vegetative state, and death). Data on 5686 patients formed the head-injury database between May 1987 and May 1999. Among these patients, ICH was the only major abnormality identified on CT scans in 90 patients. Patients with significant associated contusions were excluded. Details on these 90 patients were entered into a
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computerized database (SPSS Inc., Chicago, IL). Between November 1993 and July 1999, the SICH database contained information on 440 patients in whom complete 6-month follow-up data were available. Details on these cases were imported from one database (Access; Microsoft Corp., Redmond, WA) into another (SPSS, Inc.). We thus had two separate statistical (SPSS) databases, one for TICH and the other for SICH. All data analysis was performed using the SPSS program. Comparisons were made between patient age and GCS score at admission for TICH and SICH patients according to outcome and treatment by using the nonparametric Mann–Whitney U-test for two independent samples because of the skewed nature of the distributions. Outcome was compared with treatment by using the Pearson chi-square test.

Results

In only 1.6% of patients with head injury (90 of 5686) was ICH identified as the only major abnormality on CT scans. The prevalence of ICH in patients with closed head trauma that has been reported in the literature ranges from less than 0.5% to approximately 15%. The incidence of any type of skull fracture in the TICH group was 41%, compared with 34.5% in the entire head-injury database.

The median age of patients with TICH (51 years) was lower than that of patients with SICH (65 years), but it was significantly higher than the median age of the entire head-injury group (21 years). Among the cases comprising the head-injury database, 0.8% of patients younger than 45 years of age presented with ICH, whereas 4.3% of patients older than 45 years of age harbored an ICH. Patients older than 45 years, therefore, were more than five times more likely to present with an ICH following head injury compared with those who were younger. Fifty-six percent of the hematomas in the SICH group were lobar compared with 91% of hematomas in the TICH group (p < 0.0005, Pearson chi-square test). Traumatic hematomas tended to be more superficial. Seventy-five percent of the traumatic hematomas (compared with 54% of spontaneous hematomas) were located within 1 cm of the nearest cortical surface (p = 0.001, Pearson chi-square test). In relation to the size of the lesion, a much higher proportion of traumatic hematomas (82%) was in the medium-sized range (25–65 cm³), compared with the proportion of spontaneous hematomas (47%) in the same range. Thirty-eight percent of spontaneous and 12% of traumatic hematomas were smaller than 25 cm³ in volume. Fifteen percent of spontaneous and 6% of traumatic hematomas were larger than 65 cm³.

Of the SICH group, 24% achieved a favorable outcome at 6 months. For the TICH group, favorable outcome at 6 months was much higher at 67% (Table 1). The category favorable outcome included good recovery and moderate disability and the category unfavorable outcome included death, vegetative state, and severe disability as outlined by the GOS. In the entire head injury database, favorable outcome was 77%.

For the TICH group, the median GCS score at presentation was 14 for patients who had a favorable outcome and 7 for those who had an unfavorable outcome. A higher GCS score at presentation was a strong predictor of favorable outcome (p < 0.001). In the SICH group, the median GCS score at presentation for those patients who achieved a favorable outcome was 15 compared with 12 for patients who had an unfavorable outcome. A higher GCS score was again strongly related to a favorable outcome (p < 0.001).

Patients with favorable outcomes were also significantly younger in both groups: median age of 60 years compared with 67 years for unfavorable outcomes in patients with SICH and 43 years compared with 56 years in patients with TICH. There was a statistically significant relationship between younger patient age and favorable outcome in both TICH (p = 0.004) and SICH (p < 0.001) groups.

In 33% of patients with traumatic hematomas, the clots were surgically evacuated. In the TICH group, patients who underwent surgery had a slightly poorer outcome (38% unfavorable outcome compared with 30% in conservatively treated patients). This difference is not statistically significant (p = 0.581, Pearson chi-square test). The median age of patients who underwent surgery was 50 years and their median GCS score was 11. The median age of patients who were treated without surgery was 52 years and their median GCS score was 13. Again these differences were not statistically significant.

In comparison, only 16% of patients with spontaneous hematomas underwent surgical evacuation. The median age of these patients was 60 years and the median GCS score was 11, compared with a median age of 66 years and a median GCS score of 13 in those patients who did not undergo surgery. Outcomes were slightly poorer for patients who underwent surgery (unfavorable outcome was 83% compared with 75% in the conservatively treated patients). This difference is not statistically significant (p = 0.140, Pearson chi-square test).

Patients with favorable outcomes following SICH were separated into two groups on the basis of whether they received surgical intervention. In the group in which clots were evacuated, 50% had GCS scores less than 13. In the group that were treated without surgery, more than 50% had a GCS score of 15. This suggests that clot evacuation put patients with a relatively poor GCS score in the same league (favorable outcome) as nonsurgically treated patients who achieved favorable outcomes, but had a higher GCS score at presentation (Fig. 1). The trend was similar but less marked following TICH (Fig. 1).

Discussion

Pathogenesis and Predisposing Factors

There are similarities and differences between TICH and SICH. Spontaneous ICH usually occurs in a setting of abnormal underlying vasculature and in older people. Pre-existing hypertension and anticoagulation therapy are the
most common causes of SICH.\textsuperscript{18} On the other hand, TICH is produced by a mechanism similar to the one that produces contrecoup contusions\textsuperscript{17} when the brain moves violently within the cranium; either the tensile strain within the brain overcomes vascular resistance at a given point, leading to hemorrhage, or a concentration of shock waves secondary to impact causes mechanical disruption of blood vessels at a given point.\textsuperscript{6} In our database, the median age of patients who experience isolated ICH following head injury was much higher than the median age of the entire head injury group (51 years as opposed to 21 years). The occurrence of TICH was five times more common in those patients older than 45 years of age. Okada\textsuperscript{16} also reported that TICH was more common in middle-aged or elderly patients. This suggests that age-related changes in the brain may facilitate the development of ICH following a head injury. These changes are possibly a combination of changes in the parenchyma and the vasculature. An obvious parenchymal change that occurs with age is atrophy of the brain. The elderly and mildly atrophic brain probably does not have the same tamponading effect on a nascent hemorrhage as a younger, more abundant, and fuller brain may have, thus facilitating development of such a lesion. This hypothesis is supported by the development of ICH in patients following decompressive intracranial surgery for other lesions, which has frequently been reported.\textsuperscript{3,7,9}

The incidence of skull fracture in patients with TICH whose information was stored in our database was 41%. This is slightly higher than the 35% computed for the entire head injury database, but the difference is nonsignificant. In a study of 1383 head-injured patients Macpherson and colleagues\textsuperscript{12} found that a skull fracture was less frequently associated with an ICH compared with contusions and extradural or subdural hematoma. Alvarez-Sabin and associates\textsuperscript{1} found that there was no relationship between the intensity of injury and the development of TICH. It would therefore seem that development of TICH after a head injury may not be related to the severity of the injury, and that other predisposing factors may play an important role.

**Surgical Evacuation**

Selection of cases in our databases for surgery was largely nonrandomized and, therefore, evaluation of the effects of clot evacuation is not possible. Indeed, surgery would be expected to be performed more frequently in comatose patients. Nevertheless, the results of a subgroup analysis suggested that in patients who attained favorable outcomes, those treated surgically presented with a lower GCS score. This trend was stronger among patients with SICH; however, there was no statistically significant difference in outcomes between surgically and nonsurgically treated patients in either the SICH or TICH groups. According to our data, patients who presented with slightly poorer GCS scores and were slightly younger were more likely to undergo surgery in both the SICH and TICH groups. Nevertheless, there was no statistically significant difference in ages or in the presenting GCS scores of patients who underwent surgery and those who did not either for the SICH or TICH group. This illustrates the fact that indications for surgical intervention are not well defined for either SICH\textsuperscript{5,8} or TICH.\textsuperscript{2,13} It is also what one would expect from an observational and nonrandomized study in a neurosurgery unit.

For patients with SICH, although there have been a few randomized controlled trials in which surgery was compared with conservative management,\textsuperscript{9} no conclusive answer has thus far been found. The International STICH\textsuperscript{2} is being conducted to define the indications for surgical intervention in SICH. This trial has already recruited more than 700 patients in more than 100 centers globally.

For TICH, scientific evidence for indications for surgical intervention is even more scanty. Mathiesen, et al.,\textsuperscript{14} conducted a subgroup analysis of patients in the Head Injury Trial 2\textsuperscript{2} and found that patients with TICH attained better outcomes if their clots were surgically evacuated. This was a retrospective observation of nonrandomized patients. In another nonrandomized study of surgery and conservative management for cases of TICH Yamamoto and coworkers\textsuperscript{19} found that mortality and neurological disability were

![Box plots demonstrating the relationship between GCS score and outcome following surgery in patients with SICH and those with TICH.](image)
greater in patients who underwent surgery. Such observational studies simply reflect the fact that surgery tends to be performed in the more severely affected patients.

In the absence of objective evidence for undertaking surgery either for SICH or TICH, practice remains anecdotal, haphazard, and inconsistent. The International STICH may resolve the dilemma for SICH. A similar trial may be needed for TICH.

Patient Outcome

Sixty-six percent of all TICH patients in our database had favorable outcomes, as determined using the GOS (Table 1). This compares with a 24% rate of favorable outcome in SICH patients. Traumatic ICH, therefore, appears to carry a better prognosis than SICH. A factor that may contribute to this difference is the younger age of TICH patients.

Conclusions

Our findings suggest that TICH and SICH behave as two separate clinical entities.

Irrespective of intervention, TICH is associated with much better outcomes compared with SICH (67% compared with 24% favorable outcome, respectively). This finding warrants further investigation. In addition, patient age and presenting GCS score are strong predictors of outcomes for both types of parenchymal hemorrhage.

Spontaneous ICH is often associated with underlying vascular abnormalities. We hypothesize that TICH is caused by trauma in a brain that is mildly atrophic and does not exert the tamponading effect that may occur in a younger and more full brain, in which brain tissue is more voluminous and abundant.

Indications for surgical intervention are not well defined for either type of hemorrhage. Practice is subjective and inconsistent. The International STICH may resolve the dilemma for SICH, but not for TICH.

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References

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