Independent Risk Factors and Risk Factor Selection Modeling for the Recurrence of Chronic Subdural Hematomas

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Background

Chronic subdural hematoma (CSDH) formation is a common neurosurgical problem. Risk factors have been described, though remain controversial. Investigations into CSDH pathophysiology has not led to a decrease in their recurrence rate, reported as high as 20%. We reviewed 331 total CSDHs requiring drainage for factors predicting residual volume and operative recurrence. Independent predictors were used to create a novel scoring system to identify patients at highest risk for recurrence.

Methods

A retrospective review from January 2005 to December 2009 was completed. Clinical and demographic information was collected via an electronic medical record, and technical factors from operative notes. Pre- and post-operative radiological data was obtained using PACS. Each variable was subject to univariate and multivariate analysis using Statistical Analysis System (SAS) computer software. The results were calculated as an odds ratio and 95% confidence interval. Statistical significance was set at a p-value of less than 0.05. The risk factors identified were then used in a statistical selection method to identify the best model for a scoring system based on high-risk groups for recurrence. High-risk groups were identified based on the 75th percentile of recurrence for each factor.

Table 1: Baseline Characteristics (%)

Factor	Patient Population
Gender	
Male	267 (80.7)
Female	64 (19.3)
Mean Age (years)	
Male	69.1 ± 14.3
Female	69.4 ± 14.0
Anticoagulated	
Yes	51 (15.4)
No	280 (84.6)
CT Hematoma Density	
Hypodense	34 (10.3)
Isodense	48 (14.6)
Hyperdense	10 (3.0)
Mixed	238 (72.1)
Loculated	
Yes	244 (79.3)
No	86 (20.7)
Mean Midline Shift (mm)	7.2 ± 5.2
Brain Atrophy	
No or Mild Atrophy	77 (23.3)
Definite Atrophy	146 (44.1)
Severe Atrophy	108 (32.6)
Mean Pre-Operative Volume (cc)	130.4 ± 56.2
Hemisphere	
Left	171 (51.7)
Right	160 (48.3)

Results

A total of 331 CSDH were identified. The majority of patients were male (80.66%), and the mean age was 69 years-old. There were 16% of patients anticoagulated initially who were normalized prior to surgery. The recurrence rate was 11.78% (39 re-operations). Of these patients, 4 required a third operation for CSDH recurrence. Septations on CT scan were seen in 73.94%. In keeping with this, 72.12% of CSDH were mixed density on CT, 14.55% isodense, 10.30% hypodense, and 3.03% were hyperdense. The mean extent of midline shift was 7.18mm, mean hematoma volume was 128.81cc and most had moderate atrophy. Burr-hole drainage was done for 89.39% of CSDHs as opposed to craniotomy.

Table 2: Post-Operative Residual Hematoma Outcome

Factor	Univariate Analysis (P-Value)	Multivariate Analysis (P-Value)
Age	<0.001	0.41
CT Hematoma Density	0.50	0.42
Loculations	<0.001	0.01
Midline Shift	<0.01	0.99
Atrophy	<0.001	0.04
Pre-operative Volume	<0.001	<0.0001

The presence of septations (p-value <0.001) was found to be associated with residual hematoma. Pre-operative hematoma volume (p-value <0.01) was also statistically significant for larger residual hematoma. Furthermore, midline shift (p-value 0.01) and atrophy (p-value <0.001) were predictive of larger residual hematoma. Upon multivariate analysis, pre-operative hematoma volume (p-value <0.001), age (p-value <0.001), atrophy (p-value 0.02), and presence of septations (p-value 0.01) were all found to be independent predictors for larger residual hematoma.

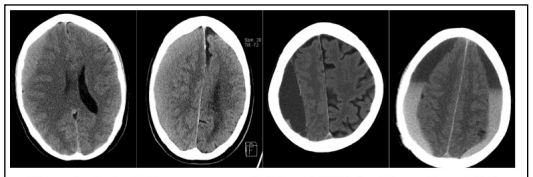

Figure 1: Typical CT appearance of different CSDH subtypes (from left to right) a) hyperdense, b) isodense, c) hypodense, and d) mixed density.

Table 3: Operative Recurrence Outcome

Factor	Univariate Analysis		Multivariate Analysis
	OR (95% Confidence Interval)	P-Value	P-Value
Gender	3.02 (0.90-10.14)	0.07	0.08
Age	1.00 (0.98-1.02)	0.95	0.91
CT Hematoma Density	1.43 (0.41-4.99)	0.68	0.39
Loculations	0.29 (0.09-0.95)		0.04
Midline Shift	0.92 (0.86-0.97)	<0.01	0.07
Atrophy	0.93 (0.59-1.47)	0.76	0.78
Pre-Operative Volume	1.01 (1.00-1.01)	<0.01	0.29
Operative Procedure	2.52 (1.06-6.04)	0.04	0.24

Univariate analysis for recurrence requiring reoperation showed pre-operative volume (p-value 0.01) and midline shift (p-value <0.01) to both be related to CSDHs requiring re-drainage. Patients having undergone burr-hole drainage (p-value 0.04) were also higher risk for requiring reoperation. Moreover, larger residual hematomas were also more likely to require a second operation for re-drainage (p-value <0.001). The only independent predictor of requiring a second operation was the presence of CSDH loculations pre-operatively (p-value 0.04).

A predictive scoring system was calculated. Patients at highest risk for reoperation were stratified based on age (80-year-old cut-off), pre-operative hematoma volume (160cc cut-off) and presence of loculations. This model was strongly associated with predicting post-operative residual hematoma volume. There was also a trend toward significance for predicting re-operation. The rate of reoperation based on hematoma recurrence for our dataset was 4.76%, 11.72%, 13.83%, and 20.69% for scores of 0, 1, 2, and 3, respectively.

Factor	Score
Age (years)	
>80	1
≤80	0
CSDH Volume (cc)	
>160	1
≤160	0
Hematoma Loculations	
Present	1
Absent	0

Discussion

Residual Hematoma

The presence of septations was statistically significant for residual hematoma. This is explained by their presence making drainage more difficult. Pre-operative hematoma volume was also significant. El-Kadi, et al. showed that larger CSDHs have a lower surface to volume ratio suggesting decreased absorption of the hematoma fluid. In our study, atrophy was also found to be a predictor of larger residual hematoma. If there is significant atrophy, then the outer membrane may continue to bleed into the subdural space resulting in recurrence.

Operative recurrence

Presence of septations was the only independent factor found to correlate with CSDH recurrence. Our event rate may not have been high enough to show statistical significance of other related factors. Interestingly, post-operative hematoma volume was associated with requiring re-drainage. A larger residual hematoma volume, may indicate that fibrinolytic factors may not have been drained to shift the balance beyond a threshold required to promote coagulation & reabsorption.

Scoring System

Patient age, hematoma volume, and presence of loculations were found to influence residual volume and operative recurrence most. Our scoring system was found to be significantly predictive of post-operative residual hematoma which in turn is correlative of repeat operation. Given a larger sample set and/or event rate, statistical significance for re-drainage may be revealed.