Use of drains versus no drains after burr-hole evacuation of chronic subdural haematoma: a randomised controlled trial

Thomas Santarius, Peter J Kirkpatrick, Dharmendra Ganesan, Hui Ling Chia, Ibrahim Jalloh, Peter Smielewski, Hugh K Richards, Hani Marcus, Richard A Parker, Stephen J Price, Ramez W Kirollos, John D Pickard, Peter J Hutchinson

Summary

Background **Chronic subdural haematoma causes serious morbidity and mortality. It recurs after surgical evacuation in 5–30% of patients. Drains might reduce recurrence but are not used routinely. Our aim was to investigate the effect of drains on recurrence rates and clinical outcomes.**

Methods **We did a randomised controlled trial at one UK centre between November, 2004, and November, 2007. 269 patients aged 18 years and older with a chronic subdural haematoma for burr-hole drainage were assessed for eligibility. 108 were randomly assigned by block randomisation to receive a drain inserted into the subdural space and 107 to no drain after evacuation. The primary endpoint was recurrence needing redrainage. The trial was stopped early because of a significant benefit in reduction of recurrence. Analyses were done on an intention-to-treat basis. This study is registered with the International Standard Randomised Controlled Trial Register (ISRCTN 97314294).**

Findings **Recurrence occurred in ten of 108 (9·3%) people with a drain, and 26 of 107 (24%) without (p=0·003; 95% CI 0·14–0·70). At 6 months mortality was nine of 105 (8·6%) and 19 of 105 (18·1%), respectively (p=0·042; 95% CI 0·1–0·99). Medical and surgical complications were much the same between the study groups.**

Interpretation **Use of a drain after burr-hole drainage of chronic subdural haematoma is safe and associated with reduced recurrence and mortality at 6 months.**

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Department of Neurosurgery, Addenbrooke's Hospital, University of Cambridge, Cambridge, UK (T Santarius MRCS, P J Kirkpatrick FMedSci, D Ganesan FRCS[SN], H L Chia MMed, I Jalloh MRCS, P Smielewski PhD, H K Richards PhD, H Marcus MRCS, S J Price FRCS[SN], R W Kirollos FRCS[SN], Prof J D Pickard FMedSci, P J Hutchinson FRCS[SN]); **and Centre for Applied Medical Statistics, Department of Public Health and Primary Care, University of Cambridge, Cambridge, UK** (R A Parker MSc)

Correspondence to:
Mr Peter J Hutchinson, Academic Department of Neurosurgery, Addenbrooke's Hospital, Hills Road, Cambridge CB2 0QQ, UK
pjah2@cam.ac.uk

Introduction

Chronic subdural haematoma, a common disorder mainly affecting elderly people, is associated with substantial morbidity and mortality.[1,2] Its incidence is about five per 100 000 per year in the general population,[3] but is higher for those aged 70 years and older (58 per 100 000 per year).[4] Because the proportion of people aged 65 years and older is expected to double worldwide between 2000 and 2030,[5] a large rise in incidence is expected.

Treatment for this disorder is generally surgical evacuation, usually resulting in great improvement in neurological condition. Three techniques are most often used—twist-drill craniostomy (diameter less than 5 mm), burr-hole craniostomy (5–30 mm), and craniotomy.[2] In a meta-analysis, Weigel and co-workers[2] showed that all three techniques have about the same mortality (2–4%). Craniotomy is associated with a much higher morbidity than is craniostomy (12·3% *vs* 3–4%), and recurrence with twist-drill craniostomy is much higher than with burr-hole craniostomy (33% *vs* 12·1%) and craniotomy (33% *vs* 10·8%). Burr-hole craniostomy, an evacuation via one or two burr holes drilled over the site of the haematoma, is the most popular surgical technique worldwide.[6–9]

Recurrence rates after the initial drainage procedure range from roughly 5% to 30%, and is a focus of research.[2,3] A recurring theme in this debate is whether postoperative drainage should be used in conjunction with burr-hole craniostomy.[3] After Laumer and co-workers'[10] prospective study, in which no difference was reported between recurrences in patients with and without drainage, emerging evidence suggests that such drainage of the subdural space lowers recurrence rates[6,8,11–13] However, further evidence from randomised controlled trials is needed to guide treatment.[2,3,14]

Most surgeons remain unconvinced about the role of drains in burr-hole evacuation. Results of a survey[9] commissioned by the Society of British Neurological Surgeons in 2006, showed that most neurosurgeons do not use drains most of the time. Perceived risk, surgeons' experience of a patient with a complication, and insufficient or a perception of insufficient evidence might play a part in their decision.[2,3] Our aim was to analyse the effect of postoperative drainage in management of chronic subdural haematoma after burr-hole evacuation.

Methods

Patients

In this single-centre block-randomised controlled trial recruitment began in November, 2004, and was stopped by the Data Monitoring Committee in accordance with the protocol in November, 2007. Patients aged 18 years or older who presented to the department of neurosurgery at Addenbrooke's Hospital in Cambridge, UK, with symptomatic chronic subdural haematoma proven by CT scan for burr-hole drainage were eligible for inclusion.

To **view the full protocol of this trial** see http://www.neurosurg.cam.ac.uk/csdht/index.html

We excluded patients with ipsilateral haematomas who had been treated within 6 months of presentation with a shunt for cerebrospinal fluid diversion in situ, and those in whom surgery other than burr-hole evacuation was indicated. Those in whom the operating surgeon judged drain insertion unsafe were also excluded.

The protocol was approved by the Cambridge Local Research Ethics Committee. Before surgery, written informed consent was obtained from the patient, or written assent was obtained from the next-of-kin of comatose patients or those otherwise unable to give consent.

Procedures

After consent or assent was obtained, the admitting neurosurgeon completed an admission proforma with information about presenting symptoms, whether the patient had had a fall, baseline mobility, amount of assistance needed in daily living, medical history, Glasgow coma score (GCS), modified Rankin scale (MRS) score,[15] presence of limb weakness, and dysphasia.

General anaesthesia was preferred, but local anaesthesia was used when the surgeon judged it to be safest. In the operating theatre the patient was positioned supine on a horseshoe headrest. Two 14 mm burr holes about 7 cm apart were drilled over the maximum width of the

	Drain	Non-drain
Age	74·4 (46–94)	77·9 (36–95)
Women	25/108 (23%)	30/107 (28%)
Pre-morbid		
Mobility		
Independent	55/70 (79%)	55/70 (79%)
Stick	10/70 (14%)	11/70 (16%)
Zimmer frame	4/70 (6%)	1/70 (1%)
Wheelchair	1/70 (1%)	2/70 (3%)
Bed-bound	0/70	1/70 (1%)
Residence		
Independent	77/99 (78%)	75/98 (77%)
Carer	16/99 (16%)	11/98 (11%)
Residential	2/99 (2%)	6/98 (6%)
Nursing	4/99 (4%)	6/98 (6%)
Medical history		
Dementia	4/101 (4%)	3/101 (3%)
Arrhythmia	14/101 (14%)	17/101 (17%)
Cerebrovascular accident	6/101 (6%)	9/101 (9%)
Hypertension	7/101 (7%)	15/101 (15%)
Ischaemic heart disease	7/101 (7%)	2/101 (2%)
DVT or PE	3/101 (3%)	0/101
COPD	0/101	1/101 (1%)
Diabetes	7/101 (7%)	3/101 (3%)
Drug history		
Anticoagulant*	21/98 (21%)	18/101 (18%)
Antiplatelet*	28/98 (29%)	36/101 (36%)
Admission		
Glasgow coma scale		
13–15	82 (83%)	81 (79%)
9–12	12 (12%)	13 (13%)
3–8	5 (5%)	9 (9%)
MRS score		
0	0/99	0/100
1	11/99 (11%)	12/100 (12%)
2	21/99 (21%)	11/100 (11%)
3	12/99 (12%)	12/100 (12%)
4	32/99 (32%)	32/100 (32%)
5	23/99 (23%)	33/100 (33%)
MRS score (median)	4	4
Hemiparesis	63/92 (69%)	52/92 (57%)
Dysphasia	32/95 (34%)	30/96 (31%)
CT		
Hypodense	13/51 (25%)	11/45 (24%)
Isodense	3/51 (6%)	5/45 (11%)
Mixed	35/51 (68%)	28/45 (62%)
Midline shift (mm)	9·6 (0–19·5)	8·8 (0–23·3)
Side		
Left	42/108 (39%)	57/107 (53%)
Right	45/108 (42%)	30/107 (28%)
Bilateral	21/108 (19%)	20/107 (19%)
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Operation		
Subdural fluid		
Absent	0/89	0/80
Clear	0/89	2/80 (3%)
Straw	7/89 (8%)	6/80 (8%)
Engine oil	49/89 (55%)	42/80 (53%)
Fresh blood	19/89 (21%)	16/80 (20%)
Mixture	14/89 (16%)	14/80 (18%)
Subdural fluid pressure		
Low	5/94 (5%)	7/98 (7%)
Medium	36/94 (38%)	38/98 (39%)
High	47/94 (50%)	41/98 (42%)
Very high	6/94 (6%)	12/98 (12%)
Membrane		
Thin	50/79 (63%)	55/85 (65%)
Thick	24/79 (30%)	25/85 (29%)
Very thick	5/79 (6%)	5/85 (6%)
Brain expansion		
Readily	58/83 (70%)	52/79 (66%)
Partial	24/83 (29%)	24/79 (30%)
None	1/83 (1%)	3/79 (4%)

Data are mean (SD), n/N (%), or median (range). DVT=deep venous thrombosis. PE=pulmonary embolism. COPD=chronic obstructive pulmonary disease. Anticoagulant=patient receiving anticoagulation treatment at time of admission. Antiplatelet=patient receiving antiplatelet treatment at the time of admission. MRS=modified Rankin scale. *Before occurrence of symptoms and signs attributable to chronic subdural haematoma.

Table 1: **Baseline characteristics**

haematoma. The dura mater was opened with a cruciate incision, and coagulated with bipolar diathermy. The subdural collection was washed out with warm Ringer's lactate saline with a 50 mL syringe, with or without a Jacques catheter. The subdural membrane loculations were not disrupted apart from those easily accessible via the burr holes. At this stage, when the surgeon judged that insertion of a subdural drain was safe, patients were randomly assigned to receive a drain or no drain.

Block randomisation was used, with random sizes of blocks ranging from eight to 12 in an allocation ratio of 1:1. Randomisation was done by the investigators with a web-based randomisation software—Random Allocation Software version 1.0.[16] Instructions to use or not use drain were kept in sealed envelopes labelled with sequential study numbers, which were opened at surgery after drain insertion was judged to be safe. The nature of this intervention did not allow for masking of treatment allocation. However, data were anonymised and clinicians were masked to outcomes when possible.

We treated bilateral haematoma as one case, and both sides received the same treatment. When a patient was assigned to no drain the subdural space was filled with Ringer's lactate saline and the scalp closed in two layers. Those assigned to a drain had a soft silicon drain (external diameter 4·7 mm and length 90 cm; pfm Produkte für Medizin AG, Cologne, Germany) inserted into the subdural space through the burr hole overlying the large part of the subdural cavity, and tunnelled for a minimum of 5 cm away from the scalp incision. The subdural space was filled with Ringer's lactate saline and the scalp was closed in two layers. The drain was connected to a soft collection bag that was kept in a dependent position for 48 h and then removed. We recorded the type of subdural liquid and degree of brain expansion (table 1).

Patients were discharged home or to a local hospital when they no longer needed specialised neurosurgical care and when the hospital was ready to receive them. Postoperative cranial imaging was not routinely done. At discharge a proforma to record surgical and medical complications, mobility, GCS, speech deficit, and limb power was completed by a medical doctor or clinical nurse practitioner who was a member of the team looking after the patient. After completion of the trial, the accuracy of recorded information was checked against the case notes of every individual.

At 6 months, a follow-up questionnaire developed for use in this trial was mailed to participants for them to complete, with assistance from a family member or carer if necessary. Participants were asked about their accommodation (own home, residential home, or nursing home) and whether their accommodation was the same as before onset of symptoms, whether they were less independent than they were before symptoms began, and about their mobility status (confined to bed, or uses a wheelchair, Zimmer frame, or stick, or walks independently). MRS scores were also established for the responders. Additionally, alive or dead status was recorded for every patient with the NHS Strategic Tracing Service, and date of death was obtained from hospital and general-practice records.

For more on the **NHS Strategic Tracing Service** see http://www.connectingforhealth.nhs.uk/systemsandservices/nsts

Two independent neurosurgeons derived imaging data from prerandomisation CT scans. The haematoma collection was classified as hypodense, isodense, hyperdense, or mixed, on the basis of the density of haematoma relative to brain tissue.[17] We established midline shift by measuring the maximum deviation of the midline structures from the midline.

The primary outcome measure was recurrence rate, defined as the rate of reoperation to treat recurrent chronic subdural haematoma in patients previously treated with burr-hole evacuation with and without drain. Recurrence was defined as occurrence of symptoms and signs attributable to an ipsilateral haematoma seen on a CT scan within 6 months of the original drainage procedure. Reoperation[2,8,11,12,18] was indicated if the original neurological deficit increased, recurred, or did not improve, or a new neurological deficit arose that needed further surgery (burr-hole evacuation with or without drainage, percutaneous aspiration, craniotomy, or craniectomy), as established by the admitting consultant neurosurgeon. Secondary outcome measures were clinical outcome at discharge and at 6 months, and length of hospital stay for neurosurgery.

Statistical analysis

The sample size was calculated on the basis of published work and retrospective audit data obtained from the logbook for the neurosurgical operating theatres at Addenbrooke's Hospital in Cambridge. We estimated that a sample size of 219 in each group (80% power) was needed to show a reduction in rate of recurrence from 20% to 10% (alpha=0·05). The trial protocol required the Data Monitoring Committee to review data after 50 new participants were recruited. The predetermined criteria for stopping the trial was a significant difference in recurrence rates or incidence of adverse effects between groups. After a meeting in November, 2007, the committee decided that stopping the trial early was justified because of the high significance of the evidence of efficacy of drain use (p=0·0031). They also noted that recurrence in no-drain patients was higher than was anticipated (24%) and further random assignment to this group would be inappropriate;[19] thus they recommended that the trial should be stopped from November, 2007.

Analyses were done on an intention-to-treat basis. The primary outcome analysis was a simple categorical frequency comparison with the χ^2 test. We analysed secondary outcome measures with various tests, dependent on the type of data. Categorical frequencies were compared with a χ^2 or Fisher's exact test. We first tested numerical data for normality with the Kolmogorov-Smirnov test, and *t* test if data were normally distributed, otherwise we used the Mann-Whitney *U* test.

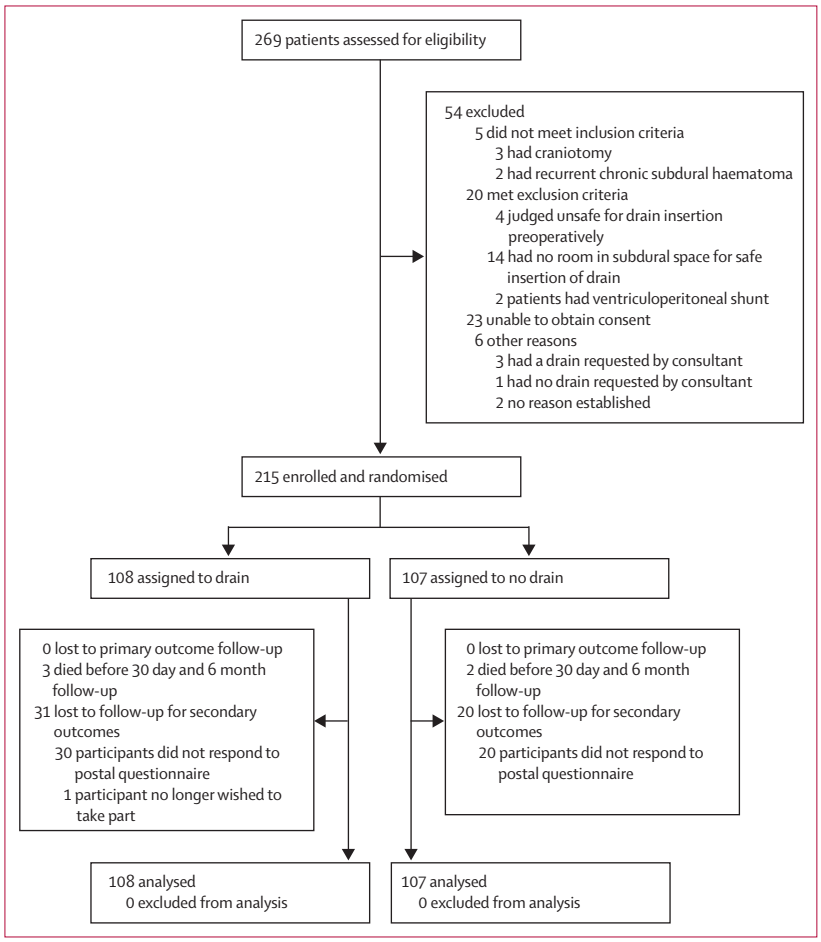

Figure: **Trial profile**

We used regression-model analyses to investigate the effect of treatment and other selected independent variables on the following outcome measures: recurrence (yes or no), mortality at 30 days (yes or no) and at 6 months (yes or no), MRS scores at discharge (4–6 or 0–3) and 6 months (4–6 or 0–3), GCS at discharge (15 or 3–14), and duration of hospital stay for neurosurgery. For the measure of duration of stay we used a linear regression model after we applied a square-root and then we applied a natural-log transformation to the response variable to help make an assumption of a normal distribution. Logistic regression models were used to analyse the outcomes that remained.

We calculated odds ratios with 95% CIs for all variables in the logistic regression models to take into account the effect of independent variables. The two exceptions were the variables corresponding to MRS scores at admission and GCS at admission, entering the logistic regression models as continuous covariates. Their corresponding coefficients on the odds scale (with 95% CIs) were included in the results. Significance was set at 5%, and all statistical analyses were done with the SPSS software version 15.0.0. All p values and CIs reported are the original results from the statistical analysis and were not corrected for multiple testing. This study is registered in the International Standard Randomised Controlled Trial Register (ISRCTN 97314294).

Role of the funding source

The sponsor of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. No funding was received from the drain manufacturer or distributor. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

The trial profile is shown in the figure. The primary outcome and duration of neurosurgical hospital admission was measured for all participants. Mortality at 30 days and 6 months was recorded in all but three patients with drains and two without drains. MRS scores at follow-up were available for 161 participants (76 treated with and 85 without drain). Completeness of other secondary outcome data varied.

Table 1 shows baseline characteristics. The groups were well matched. Mean age of the participants was 76·8 years (SD=10·6), ranging from 36 years to 95 years. 160 men and 55 women were included, and the sex ratio was 2·9:1.

Table 2 shows the frequencies of presenting symptoms. Gait disturbance and falls, mental deterioration, hemiparesis, headache, speech impairment, and drowsiness or coma were most common and, apart from drowsiness or coma, could be the sole presenting symptom. About a third of patients presented with one symptom (68, 33%), a third with two (74, 37%), and those remaining with three (46, 22%), four (16, 8%), and five (1, <1%). A history of head injury was established in 119 of 196 (61%). At examination, 86 (42%) of patients had GCS of 15, 102 (50%) 9–14, and 14 (7%) less than 8. Limb weakness was recorded in 111 of 184 (63%), dysphasia in 62 of 191 (33%), and either in 136 of 192 (71%) of cases.

The rate of recurrence was significantly lower in the drain than in the no-drain group (table 3). It was also much lower when unilateral haematomas only were counted. Time-to-recurrence was longer in the drain (median 15·5 days, IQR 4–46) than in the no-drain (8, 5–12) groups (p=0·0247; Mann-Whitney *U* test). After adjustment for haematoma laterality, the presence of coagulopathy, platelet dysfunction, admission GCS, MRS score, and neurological deficit, the results of the logistic regression analysis also showed that a drain significantly reduced the probability of recurrence (table 4). No other factor had a significant association with recurrence.

At 30 days, mortality did not differ between groups (table 4). Significantly more patients treated with drains were alive at 6 months than were those with no drains. Logistic regression analysis gave a similar result after adjustment for haematoma laterality, presence of coagulopathy and platelet dysfunction, or both,

admission GCS, MRS score, and neurological deficit (table 4). MRS score at admission was noted to be a significant predictor of death at 6 months, after adjustment for the other variables.

A discharge GCS of 15 was recorded in more participants with a drain than in those without (table 4). With the logistic regression model, drain was identified to increase and a high admission MRS score to decrease the probability of a GCS of 15 at discharge. Gross neurological deficit (limb weakness or dysphasia) at discharge was significantly less frequent in those with than in those without a drain, but did not differ at 6 month follow-up (table 3).

We noted instability of a logistic regression model of gross neurological deficit at discharge with the same set of independent variables entering the model, and hence we omitted this model from table 4. This instability was because all patients with a gross neurological deficit at discharge had a deficit at admission. Therefore, the variable for neurological deficit at admission was a very strong and important predictor of deficit at discharge, masking the effect of other variables—eg, drain. However, we noted that for all with this deficit at admission, fewer (19 of 67; 28%) with a drain had a deficit at discharge than did those without (29 of 57; 51%). Significantly more patients had neurological deficit at discharge in the no-drain group than in the drain group.

Favourable MRS scores (0–3) at discharge and 6 months were recorded in significantly more patients with drain than with no drain (table 3). However, after adjustment for confounding factors, drain was not predictive of MRS score at 6 months (table 4). By contrast, admission MRS score was a significant predictor of this score at 6 months (table 4). Requirements for care and mobility did not differ between the groups at 6 months (table 3). We identified admission GCS as a strong predictor of duration of neurosurgical hospital stay, when adjusted for variables (webappendix p 1). Duration of stay was much greater in cases with than in cases without recurrence ($p<0·0001$).

We recorded postoperatively three subdural empyemas (one in drain and two in no drain), one intracerebral haematoma (no drain), one acute subdural haematoma needing evacuation (no drain), five pneumonias (three in drain and two in no drain), two renal failures (one in each group), two urinary tract infections (one in each group), one myocardial infarction (drain), one new-onset of atrial fibrillation (no drain), and one patient had gastritis (no drain).

38 patients (19%) had at least one missing value in the explanatory variables. 14 had values missing from admission GCS, 17 from admission MRS scores, 22 from presence of platelet dysfunction or coagulopathy, and 26 from presence of neurological deficit at admission, but none from drain and laterality. Values were assumed to be missing at random.

To further investigate the effect of missing values, we introduced an indicator variable of 1 for patients with at least one missing value and 0 for those with more than one. With complete data for 215 patients, we undertook logistic regression analysis on every outcome measure with the covariates drain, laterality, and the newly constructed missing-indicator variable. Similarly, we undertook a linear regression with these covariates for the transformed variable for duration of hospital stay.

The indicator variable for missing data was not significantly associated with any outcome variables,

	Patients (n=205†)
Gait disturbance or falls	116 (57%)
Mental deterioration	71 (35%)
Limb weakness	71 (35%)
Acute confusion	67 (33%)
Headache	36 (18%)
Drowsiness or coma*	20 (10%)
Speech impairment	12 (6%)
Non-specific deterioration*	7 (3%)
Collapse*	2 (1%)
Seizure*	2 (1%)
Incontinence*	1 (<1%)
Visual disturbance*	1 (<1%)
Vomiting*	1 (<1%)

Data are number (%) of patients. *Never occurred as a sole presenting symptom. †Number of patients for whom presenting symptoms were available.

Table 2: **Presenting complaints**

	Drain	No drain	Odds ratio (95% CI)	p value
Recurrence				
All	10/108 (9%)	26/107 (24%)	0·32 (0·14–0·70)	0·0031
Bilateral CSDHs excluded*	9/87 (10%)	23/87 (26%)	0·32 (0·14–0·74)	0·0062
Mortality (drain *vs* no-drain)				
At 30 days	4/106 (4%)	8/105 (8%)	0·48 (0·14–1·63)	0·2278
At 6 months	9/105 (9%)	19/105 (18%)	0·42 (0·18–0·99)	0·0424
Rankin (MRS 0–3)				
At discharge	81/97 (84%)	64/95 (67%)	2·38 (1·23–4·87	0·0093
At 6 months	64/76 (84%)	60/85 (71%)	2·22 (1·03–4·81)	0·0403
GCS of 15 (at discharge)	76/94 (81%)	62/97 (64%)	2·38 (1·23–4·61)	0·0090
Gross focal neurological deficit†				
At discharge	47/93 (51%)	63/96 (66%)	0·54 (0·3–0·96)	0·0355
At 6 months	11/69 (16%)	11/63 (17%)	0·9 (0·36–2·24)	0·8146
Hospital stay (days)				
In neurosurgical unit	5 (3–9)	6 (3–11)	NA	0·1648
In local hospital	0 (0–1)	0 (1–3)	NA	0·6843
High level of care at 6 months	5/67 (7·5%)	9/67 (13%)	0·52 (0·16–1·64)	0·2586
Worse mobility at 6 months	8/51 (15.7%)	14/51 (28%)	0·49 (0·19–1·30)	0·1486

Data are number/total in group (%) or median (IQR). χ^2 test used for outcome measures except for hospital stay, which was compared by Mann-Whitney *U* test. CSDH=chronic subdural haematoma. MRS=modified Rankin score. GCS=Glasgow coma scale. NA=not applicable. *Left or right side only. †Hemiparesis or dysphasia.

Table 3: **Primary and secondary outcome measures in drain and non-drain groups**

	Odds ratio* (95% CI)	p value
Recurrence rate		
Drain	0·34 (0·14–0·85)	0·0210
Admission GCS	0·89 (0·71–1·11)	0·3000
Admission MRS	0·87 (0·60–1·27)	0·4770
Admission neurological deficit†	1·24 (0·43–3·55)	0·6930
Unilateral haematoma	0·68 (0·21–2·23)	0·5280
Coagulopathy or platelet dysfunction	0·74 (0·31–1·78)	0·5010
Mortality at 30 days		
Drain	0·45 (0·11–1·94)	0·2870
Admission GCS	0·91 (0·70–1·20)	0·5180
Admission MRS	2·67 (1·00–7·16)	0·0510
Admission neurological deficit†	0·72 (0·12–4·41)	0·7210
Unilateral haematoma	0·90 (0·17–4·90)	0·9030
Coagulopathy or platelet dysfunction	1·60 (0·38–6·73)	0·5220
Mortality at 6 months		
Drain	0·35 (0·13–0·92)	0·0330
Admission GCS	0·89 (0·73–1·09)	0·2710
Admission MRS	2·20 (1·24–3·90)	0·0070
Admission neurological deficit†	1·34 (0·37–4·85)	0·6520
Unilateral haematoma	0·94 (0·30–3·02)	0·9230
Coagulopathy or platelet dysfunction	0·90 (0·36–2·27)	0·8210
Unfavourable MRS (4–6) at discharge		
Drain	0·35 (0·14–0·92)	0·0330
Admission GCS	1·13 (0·91–1·40)	0·2830
Admission MRS	5·25 (2·34–11·79)	<0·0001
Admission neurological deficit†	15·12 (1·71–133·60)	0·0150
Unilateral haematoma	0·56 (0·15–2·09)	0·3920
Coagulopathy or platelet dysfunction	1·54 (0·60–3·94)	0·3670
Unfavourable MRS (4–6) at 6 months		
Drain	0·56 (0·23–1·38)	0·2073
Admission GCS	0·93 (0·74–1·17)	0·5321
Admission MRS	1·82 (1·12–2·95)	0·0147
Admission neurological deficit†	1·69 (0·52–5·45)	0·3829
Unilateral haematoma	0·52 (0·17–1·66)	0·2711
Coagulopathy or platelet dysfunction	1·22 (0·51–2·90)	0·6594
GCS of 15 at discharge		
Drain	2·50 (1·07–5·79)	0·0334
Admission GCS	1·02 (0·83–1·23)	0·8827
Admission MRS	0·38 (0·23–0·63)	0·0002
Admission neurological deficit†	0·78 (0·26–2·39)	0·6641
Unilateral haematoma	1·85 (0·58–5·88)	0·2947
Coagulopathy or platelet dysfunction	1·69 (0·72–3·94)	0·2272

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Adjusted odds ratios take into account the effect of other independent variables. For example, the ratio of odds of recurrence for the drainage group relative to the no-drainage group, adjusted odds ratio of 0·34 adjusts for the effect of laterality, presence of coagulopathy or platelet dysfunction, or both, admission Glasgow coma scale (GCS), admission modified Rankin scale (MRS), and admission neurological deficit; all of which have the potential to modify the relation between drainage and recurrence. *Except admission GCS and MRS, which both enter the model as continuous covariates. †Hemiparesis, or dysphasia, or both at admission.

Table 4: **Outcome analysis with adjusted logistic regression models, by independent variable**

adjusting for drain and laterality. Additionally, conclusions related to drain and laterality were unchanged after adjustment for the effect of any missing data. The only exception was for MRS score at 6 months, for which drain differed significantly between groups. However, the relation between drain and MRS score was not significant after adjustment for the full set of covariates with logistic regression modelling.

44 values (21%) were missing from follow-up MRS scores, 26 from these scores at discharge, and 24 from GCS at discharge. All other outcome variables (including the primary-outcome variable) were complete. Incomplete data for a response variable will not bias the results of a logistic regression when we assume the missing data are missing at random. Furthermore, missing values in the outcome measures were few. Nevertheless, we did a sensitivity analysis on follow-up MRS scores to investigate the effect on our logistic regression results. This analysis showed that use of drains is not predictive of 6 month MRS scores, which is consistent with the findings of the original logistic regression analysis.

Discussion

We have shown that patients with chronic subdural haematoma treated with burr-hole evacuation and postoperative drainage had a recurrence rate roughly half that of those without drainage. Mortality was lower at 6 months' follow-up for those with drains. At discharge, patients with drains had better functional status, more had favourable MRS scores and a GCS of 15, and fewer had neurological deficits than those without drains. Surgical complications were not increased in those with drains.

Our findings accord with results from two prospective studies.[11,12] Wakai and co-workers[11] reported recurrence rates of 5% for drain and 33% for no drain, and Tsutsumi and co-workers[12] reported rates of 3·1% and 17%, respectively. We report recurrence rates very similar to those in the retrospective study by Lind and co-workers[6] who identified recurrence rates of 10% for drain and 19% for no drain, and that of Mori and Maeda[13] who showed a recurrence rate of 9·8% for use of drains. These results are consistent with a positive effect of drains in prevention of postoperative recurrent collections, and their use could avoid repeated operations and additional time in hospital. We did not identify any reports exploring the use of drains in burr-hole evacuation of chronic subdural haematoma to alter patient outcomes. However, a rapid clinical improvement for those with a raised chronic subdural haematoma

pressure has been reported.[20,21] The weaknesses of our study are that it was a single centre rather than a multicentre study and that some data were missing, although these missing data did not affect the main findings for recurrence rate and mortality.

The exact reason for reduced mortality at 6 months with use of a drain is unclear, but this finding might be representative of a rapid and complete neurological recovery, hence improved mobility. With a logistic regression model we identified that drains did not significantly improve the probability of a favourable MRS score at 6 months when adjusted for variables. This finding could be attributable to a strong effect of the natural history of chronic subdural haematoma on MRS score. In turn, it could mean that drain has no significant effect on this score at 6 months, but could also show the insufficient power of the model and data, especially because 6 month MRS data for about 25% of people were unavailable.

We were surprised by the absence of difference between groups in overall duration of hospital stay in the specialist neurosurgical unit. This finding might relate to the low frequency of recurrent cases, and consequently their small effect on overall distribution of values within their cohorts. However, the potential benefit of drainage can be calculated by subtraction of the total number of patient-days of recurrent cases with drains from those without drains—ie, if drains had been used routinely in our neurosurgical unit (90 patients per year), 92 patient-days would have been saved every year.

The multiple linear regression model identified admission GCS and presence of coagulopathy as the two factors most strongly associated with duration of hospital stay in a neurosurgical unit. This result was not surprising because patients with greatly depressed consciousness at arrival will probably need an extended time to recover before discharge. Increased patient numbers are needed to identify other factors associated with length of hospital stay in those with chronic subdural haematoma.

Concern about heightened operative risk was the main reason why most neurosurgeons in the UK and Ireland preferred to avoid use of drains.[9] Similar to other published accounts,[6,11,12,21] we could not identify any difference in frequency of medical or surgical complications between drain and no drain groups. Baseline characteristics, general management and surgical techniques, and distribution and frequency of postoperative complications of our study were similar with those of other series.[2,6,8,13] Results of our study lend support to use of drains after burr-hole evacuation of chronic subdural haematoma.

Contributors

TS was the lead investigator and contributed with PJH to writing the report. PJH was the chief investigator and the senior author of the report. SJP, RWK, JDP, and PJK assisted with setting up the project and its promotion and helped with editing of the report. DG, HLC, IJ, and HM collected and processed the data. PS, HKR, and RAP processed data and provided statistical advice and analysis.

Conflicts of interest

We declare that we have no conflicts of interest.

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