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Medical versus surgical therapy for spontaneous intracranial hemorrhage

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Nontraumatic intracerebral hemorrhage (ICH) affects approximately 37,000 to 52,400 people per year in the United States and has the highest mortality rate among stroke subtypes [1,2]. Despite the prevalence and lethality of this disease, there are relatively few randomized clinical trials on which medical and surgical management decisions can be based. For this reason, there is considerable variability in ICH management among physicians worldwide. Recently reported operation rates for spontaneous supratentorial ICH have varied from 3% in Hungary to 90% in Lithuania [3]. Results from a prospective randomized trial reported by McKissock et al [4] in 1961 established the standard for ICH management during the era before CT; hematoma evacuation offered no benefit over medical management. Since then, however, randomized studies, nonrandomized controlled studies, and meta-analyses have yielded conflicting results [5–13].

In this review, we briefly describe the available randomized and controlled nonrandomized studies comparing medical with surgical ICH management. The meta-analyses of these randomized trials are also reviewed. Apparent treatment guidelines that seem to have emerged from these sources as well as the suggested guidelines offered by the American Heart Association Stroke Council are presented [14]. Directions for future investigation are also considered.

Surgical versus medical intracerebral hemorrhage management: randomized trials

Although cerebellar and pontine hemorrhages are considered by some to be forms of ICH, our review is limited to hemorrhages within supratentorial (cerebral) sites (ie, basal ganglia, thalamus, subcortical). To date, there are seven prospective, randomized, controlled studies comparing the surgical and medical management of ICH [4–7, 10,11,13]. Surgical interventions included craniotomy, craniectomy, stereotactic needle aspiration, and stereotactically guided endoscopic aspiration [31,32]. All studies but one were performed since CT became available [4]. Also of note, the study by Chen et al [7] included intracerebellar hemorrhage in addition to ICH. Assessed individually, these studies failed to demonstrate a clear superiority of surgical or medical management. A brief summary of each randomized trial follows.

In 1961, before the advent of CT, McKissock et al [4] randomized 180 ICH patients to surgical (n = 89) or medical (n = 91) treatment. The surgical treatment consisted of craniotomy and hematoma evacuation in this study. There was a significant trend toward a higher chance of death or dependence with surgical compared with medical management (odds ratio [OR] = 2.0; 95% confidence interval [CI]: 1.04–3.86). Diagnosis was based on clinical examination, lumbar puncture, and cerebral angiography, and confirmed that diagnostic errors occurred in 5% of patients. For this reason, it is difficult to interpret the relevance of these results to ICH treatment before the era of CT. Other methodologic factors make their conclusion difficult to interpret. Surgery was performed only after hematoma localization (60% of patients randomized to the surgery group),

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which may have led to delayed intervention. Also, patients randomized to the surgical treatment group did not undergo a craniotomy if the hematoma was limited to the basal ganglia or thalamus, further limiting the applicability of these findings to all ICH patients.

Juvela et al [10] randomized 52 ICH patients to surgical (n = 26) or medical (n = 26) management between 1982 and 1986. Diagnosis was confirmed by CT. Only patients with severe neurologic deficits and/or a decreased level of consciousness were included. Surgery consisted of craniotomy and was performed within 48 hours of symptom onset. The 6-month mortality rate was 46% for surgery and 38% for medical management, with 7% and 31% functional independence at 6 months, respectively. Despite improved diagnostic methods (ie, CT confirmation), differences in mortality and functional outcome rates between the surgical and medical treatment groups were not statistically significant. General conclusions about the benefits of operative management are limited by significant differences between treatment groups. The surgery group had a significantly lower presenting Glasgow Coma Scale (GCS) score and a significantly higher rate of intraventricular hemorrhage, both of which have been associated with a poorer outcome.

Auer et al [5] randomized 100 patients with supratentorial ICH to surgical (n = 50) or medical (n = 50) management between 1983 and 1986. Diagnosis was confirmed by CT, and only patients with subcortical, putaminal, or thalamic hemorrhages greater than 10 cm^3 were included. Patients with evidence of aneurysm, arteriovenous malformation (AVM), brain tumor, or head injury were excluded. Surgery was performed within 48 hours of symptom onset and consisted of stereotactically guided endoscopic drainage. Interestingly, patients with subcortical hematomas treated surgically showed a significantly lower mortality rate (30%) than those with similar lesions treated medically (70%; $P < 0.05$). Patients who underwent surgery with no postoperative neurologic deficits had a significantly better outcome at 6 months than those managed medically. Patients with hematomas smaller than 50 cm^3 treated surgically had a significantly better functional recovery than did similar patients treated medically; however, mortality was similar. Patients who were alert or somnolent before surgery (but not stuporous or comatose) with hematomas greater than 50 cm^3 showed significantly lower mortality after surgery compared with similar patients managed medically. Functional recovery, however, was not significantly different between these groups. Among patients with putaminal or thalamic hemorrhage, there was a trend toward better quality of survival and chance of survival after surgery compared with medical management, but these differences were not significant.

Batjer et al [6] randomized 17 patients with putaminal ICH to surgical (n = 8) or medical (n = 9) therapy between 1983 and 1989. Diagnosis was confirmed by CT, and only patients with putaminal hemorrhages greater than or equal to 3 cm in diameter with or without ventricular hemorrhage were included. Surgery consisted of craniotomy. Death or dependence rates were 75% after surgery and 78% after best medical management. These differences were not statistically significant.

Chen et al [7] randomized 127 ICH and cerebellar hemorrhage patients to surgical (n = 64) or medical (n = 63) management between 1986 and 1990. Surgery consisted of craniotomy, stereotactic evacuation, craniectomy, or ventricular drainage. At 1 month of follow-up, medically treated patients had an increased rate of excellent outcome compared with surgically treated patients, but this effect was not seen at 3 months of follow-up. Although there were no significant differences in mortality between the two groups, there was a trend toward an increased risk of death or dependence after surgery (OR = 1.66; 95% CI: 0.82–3.3). General conclusions about the benefits of operative management are limited by significant differences in consciousness ($P < 0.001$), size of hematoma ($P < 0.001$), and presence of hemiplegia ($P < 0.01$) between treatment groups.

Morgenstern et al [11] randomized 34 ICH patients to surgical (n = 17) or medical (n = 17) therapy between 1993 and 1996. Patients with extensive intraventricular hemorrhage were excluded. Surgery consisted of craniotomy within 12 hours of the ictus. Mortality rates at 1 month (surgery 6%, medical 24%) and 6 months (surgery 17%, medical 24%) of follow-up were not significantly different between the two groups. The surgical group had significantly fewer lobar and more putaminal hemorrhages compared with the medical group. These differences may have influenced the measured outcomes independent of treatment.

Zuccarello et al [13] randomized 20 ICH patients to surgical (n = 9) or best medical therapy (n = 11) over a 1-year period. Inclusion criteria were ICH volume greater than 10 cm^3, focal neurologic deficit, GCS score greater than 4 at time of enrollment, and randomization within 24 hours of symptom onset. Patients with evidence of a ruptured aneurysm or AVM were excluded. Surgery consisted of craniotomy (n = 5) or stereotactic drainage (n = 4) within 3 hours of randomization (ie, within 27 hours of symptom onset). There was no significant difference in mortality (surgery 22%, medical 27%) or most secondary outcome measures (median Glasgow Outcome Scale, Barthel Index, and Rankin Scale) between the two treatment groups at 3 months. There was, however, a significant difference in the National Institutes of Health Stroke Scale score at 3 months (surgical = 4, medical = 14; $P = 0.04$).

Surgical versus medical management: meta-analyses of randomized trials

Systematic reviews with meta-analysis of the prospective randomized studies discussed previously have been performed [8,9,15]. Because there is considerable heterogeneity between them in terms of diagnostic method (the study by McKissock et al [4] predates the availability of CT), surgical technique (craniotomy, craniectomy, stereotactic drainage, and stereotactically guided endoscopic drainage), hematoma location (lobar, deep, ventricular, cerebellar), timing of surgery, and severity of neurologic deficits on presentation, the benefit of meta-analysis is limited. Prasad and Shrivastava [12] performed a meta-analysis combining the first four studies (McKissock et al [4], Juvela et al [10], Auer et al [5], and Batjer et al [6]). When the study by Auer et al [5] involving endoscopic evacuation was excluded, there was a statistically nonsignificant increase in the odds of death and dependency associated with craniotomy (OR = 1.99; 99% CI: 0.92–4.31). This held true when the pre-CT era study by McKissock et al [4] was excluded. Interestingly, the single study involving stereotactically guided endoscopic drainage showed that surgery was associated with a statistically significant reduction in the odds of death of 68% (99% CI: 10% reduction to 89% reduction) and a statistically nonsignificant trend in reduction in the odds of death/dependence of 55% (99% CI: 85% reduction to 33% excess). Although no definite conclusions were drawn from their analysis, Prasad and Shrivastava [12] stated "it would appear that craniotomy has a trend to do more harm than good." These findings were corroborated in a similar analysis by Hankey and Hon [9].

More recently, Fernandes et al [8] performed further a meta-analysis that included an additional randomized study by Chen et al [7] published in 1992 as well as two subsequent randomized studies by Morgenstern et al [11] in 1998 and Zuccarello et al [13] in 1999. Combining the seven available randomized studies, surgery was associated with a trend toward a higher chance of death/dependency compared with medical management (OR = 1.20; 95% CI: 0.83–1.74). The analysis was repeated excluding the studies by McKissock et al [4] and Chen et al [7]. The study by McKissock et al [4] was excluded because of the unavailability of CT, concomitant diagnostic error rate of at least 5%, and uncertainty about the number of patients randomized to the surgery treatment group who actually received the assigned treatment. The study by Chen et al [7] was excluded because of undefined exclusion criteria, uncertainty about the methods of data collection, the inclusion of cerebellar hematomas, significant differences in level of consciousness and hematoma size, and the presence of hemiplegia between the treatment groups. Contrary to the analyses by Prasad and Shrivastava [12] and Hankey and Hon [9], meta-analysis of the five remaining studies (Juvela et al [10], Auer et al [5], Batjer et al [6], Morgenstern et al [11], and Zucarello et al [13]) showed a nonsignificant reduction in the chances of death and dependence after surgery by a factor of 0.63 (95% CI: 0.35–1.14). Although these meta-analyses seem to indicate that there is no greater benefit from surgical or medical management, the results are conflicting and limited by the considerable methodologic differences between randomized trials.

Surgical versus medical intracerebral hemorrhage management: nonrandomized controlled studies

To date, there are three nonrandomized retrospective studies of surgically managed supratentorial ICH with medically managed historical controls [16–18]. Although they are retrospective and therefore limited as far as providing grounds for definitive conclusions, they do provide valuable insights. Each is discussed briefly below. Other reported series of surgery for ICH either do not include medically treated controls or include infratentorial hemorrhages in their analysis and are therefore not considered here.

Brambilla et al [17] retrospectively analyzed 86 ICH patients treated surgically (n = 37) or medically (n = 49) between 1976 and 1980. The considerations on which the decision to operate was made are not stated; however, surgically treated patients tended to be more likely to have superficial hemorrhages, whereas patients treated medically had a roughly even distribution between deep and superficial hemorrhages. There was no significant difference in mortality rates assessed at 1 month or at 4 to 8 months between surgically treated patients (62.2%) and medically treated patients (42.9%). The authors observed that for patients with deep hematomas, the difference between mortality rates after surgical (71.5%) and medical (26.1%) management was "markedly" different, however. In conclusion, they submit that there is a lack of superiority of one treatment strategy over the other and that medical therapy may be more appropriate for deep lesions.

Bolander et al [16] retrospectively analyzed 74 ICH patients treated surgically (n = 39) or medically (n = 35) between 1976 and 1980. Surgery consisted of craniotomy, and the decision to operate was based on the patient's neurologic condition and CT findings. "Moderately large" hematomas not involving the thalamus underwent surgical treatment, whereas patients with small hematomas or patients in "bad condition" at presentation were treated medically. There was no significant difference in mortality assessed at 3 months between the surgically (13%) and medically (20%) treated groups. The authors suggest that their overall low mortality rate compared with previous studies was likely a result of appropriate surgical intervention in select patients.

Waga and Yamamoto [18] retrospectively analyzed 74 patients specifically with hypertensive putaminal hemorrhages treated surgically (n = 18) or medically (n = 56) between 1977 and 1980. All patients admitted in 1977 underwent surgery (craniotomy), and all patients admitted between 1978 and 1980 were treated medically without surgery. Patients treated medically had a significantly lower mortality rate (14%) than those treated surgically (28%). In addition, there was a trend toward better neurologic outcome at 6 months (return to work with or without minimal neurologic deficit) for patients treated medically (60%) compared with those treated surgically (31%). Because all lesions in this study were putaminal, the findings lend support to the idea that deep lesions are best treated medically.

Few definitive conclusions can be drawn from the randomized studies when considered individually or with meta-analysis. The most conservative interpretation is that there seems to be no difference between surgical and medical management of ICH. The failure to establish the superiority of one treatment approach over the other, however, is most likely a result of the analysis of small numbers of patients, considerable variability in lesion location within and between studies, and lack of consistency in methodology between studies.

Variables affecting outcome

Prospective randomized trials and meta-analyses comparing various surgical procedures with best medical management have failed to provide consistent definitive evidence on which firm ICH treatment guidelines can be based. Similarly, retrospective controlled studies have provided limited insights. This is in part a consequence of considering all ICH as a single disease entity. When patient and treatment variables, such as lesion location, lesion size, presenting neurologic examination, and surgical technique are taken into account, implied guidelines begin to emerge.

Intracerebral hematoma location

The literature summarized previously indicates that there may be some benefit from the surgical treatment of more superficial (ie, lobar) hemorrhages, whereas there is no apparent benefit from surgery for ICH arising from the basal ganglia or thalamus. Lobar and deep ICH often represents separate disease processes, each associated with different comorbidities and mortality rates. For example, most lobar hemorrhages result from amyloid angiopathy, which is often associated with dementia and advanced age, whereas most deep hematomas result from hypertension, which may be associated with long-standing hypertension, diabetes, and heart disease.

The basal ganglia are the most common site of supratentorial ICH and are associated with a 50% mortality rate [4,15,18–20]. Although modern microsurgical, stereotactic, and endoscopic techniques can theoretically minimize surgical morbidity from basal ganglia hematoma evacuation, several studies have found no benefit or worse outcome with surgery. In 1961, McKissock et al [4] reported a nonsignificant difference in mortality between surgically and medically treated basal ganglia hemorrhages (75% and 62% respectively). Similarly, studies since the advent of CT investigating the effectiveness of standard craniotomy have failed to demonstrate any benefit of surgery for deep ICH [6,10,18]. Brambilla et al [17] demonstrated a markedly higher mortality rate among patients who underwent surgery (surgical [71.5%] versus medical [26.1%]). In a subset of 40 patients with putaminal ICH, Auer et al [5] failed to demonstrate any benefit from the theoretically less invasive method of stereotactically guided endoscopic hematoma evacuation. The only reported benefit from surgical evacuation of basal ganglia hematomas was demonstrated by Kanno et al [21], who retrospectively investigated the outcome of surgical and medical management of 265 patients with putaminal ICH. A subset of these patients with severe putaminal ICH had a better functional outcome with surgery compared with medically treated controls. No difference in mortality or functional outcome was noted between the treatment groups among patients with mild or moderate putaminal ICH, however. In conclusion, to date, there is no evidence in support of the surgical evacuation of basal ganglia ICH.

There is less controversy over the management of thalamic ICH. Anatomically, the thalamus is difficult to access safely. There is a high risk of causing neurologic deficits from parietal lobe, internal capsule, or transcallosal transventricular dissection to this deeply seated structure surrounded by edematous parenchyma. Furthermore, evacuation of thalamic lesions may damage surrounding functional thalamic tissue made susceptible by edema. In a randomized trial, Auer et al [5] treated nine thalamic ICH patients surgically via endoscopic evacuation and six medically. There was no significant difference in outcome. The available controlled nonrandomized studies either did not analyze the subset of thalamic hematoma patients or included too few operatively managed thalamic ICH patients for statistical analysis (Bolander et al [16], Kanno et al [21]). In cases of thalamic ICH, surgery is generally limited to ventricular drainage when third ventricular outlet obstruction is present [20]. Currently, there is no evidence to support the operative evacuation of thalamic ICH lesions.

Few studies comparing surgical and medical ICH management have separately analyzed the subset of patients with lobar hemorrhages. McKissock et al [4] found no significant difference in mortality after surgical (62%) or medical (46%) management. Brambilla et al [17] and Bolander et al [16] also failed to identify a significant difference in mortality between the two treatments. In 1989, however, Auer et al [5] found a significantly higher rate of good outcome and survival after endoscopic evacuation of subcortical hematomas (but not putaminal or thalamic hematomas) compared with medical management. This evidence suggests that stereotactically guided endoscopic hematoma evacuation but not craniotomy is superior to medical management for patients with superficial ICH.

Hematoma volume

Hematoma volume is associated with increased mass effect and positively correlates with the severity of neurologic deficit [17]. Furthermore, as hematoma volumes increase, mortality rates increase [5,16,17]. Retrospective studies by Brambilla et al [17] and Bolander et al [15] failed to demonstrate any effect of surgery on this possible correlation compared with medically treated controls. In a randomized study, however, Auer et al [5] demonstrated that endoscopic evacuation of hematomas greater than 50 cm^3 ($n = 22$) decreased mortality compared with medical treatment ($n = 24$) but did not improve survival quality. Conversely, among patients with hematomas less than 50 cm^3 ($n = 28$), endoscopic evacuation did not decrease mortality but did improve quality of survival compared with medical treatment ($n = 26$).

Timing of surgery

Whereas earlier studies in which hematoma evacuation surgery was performed a few days after the onset of symptoms clearly showed no benefit compared with medical therapy, modest benefits have been seen in surgical treatment with early craniotomy. Morgenstern et al [11] demonstrated comparative improved neurologic function if patients were operated on within 12 hours of the onset of symptoms. In a follow-up study evaluating ultraearly (less than 4 hours) surgery, they found an increased rehemorrhage rate [22]. Rebleeding occurred in 40% of the patients treated within 4 hours compared with 12% of the patients treated within 12 hours ($P = 0.11$). They also found an increased mortality rate in patients with rehemorrhage ($P = 0.03$). These results imply that the optimum timing of surgery in spontaneous ICH may be within the 4- to 12-hour window after hemorrhage.

Level of consciousness

A severely depressed level of consciousness (ie, GCS score <7) on presentation is associated with a worse outcome from ICH [5,10,18]. Several randomized and nonrandomized studies have investigated whether or not surgical intervention can mitigate this negative impact compared with medical management. Two nonrandomized studies by Brambilla et al [17] and Waga and Yamamoto [18] failed to demonstrate any effect of surgery on the trend toward higher mortality rates with increasingly depressed levels of consciousness at presentation. Similarly, the randomized study by McKissock et al [4] failed to show any effect of surgery when age was considered. Although the 52 randomized patients reported by Juvela et al [10] failed to demonstrate any benefit of surgery compared with medical management alone, there was a significant decrease in mortality for the surgery group (0/5 patients died) compared with the medical group (4/5 patients died) for patients presenting with a GCS score ranging from 7 to 10 ($P = 0.048$). No such benefit of surgery was demonstrated for patients presenting with a GCS score of 3 to 6 or 11 to 14. The significant benefit of surgery on mortality rates and functional outcomes reported by Auer et al [5] was only present in the subset of patients who presented alert or somnolent. There were no such benefits of surgery over medical management among the subset of patients who presented stuporous or comatose. From the results of these CT-era randomized trials, it may be concluded that any benefit of surgery over medical management can only be observed in patients who are alert or with only minimally depressed levels of consciousness.

Age

In their randomized study, Auer et al [5] investigated the effect of age. They demonstrated that for patients less than 60 years of age, surgery led to a decrease in mortality compared with medical management. Mortality rates were not significantly different between surgical management and medical management for patients greater than 60 years of age.

Treatment recommendations

Based strictly on the results of these studies, surgery does not seem beneficial for patients with basal ganglia or thalamic ICH. Surgery may be most beneficial when reserved for patients with subcortical ICH who are less than 60 years of age without a profoundly impaired level of consciousness at presentation. Given the considerable variability in methodology and numbers of subjects (ie, statistical power), these observations and implied guidelines should not be considered definitive.

After a broader review of the literature, the American Heart Association Stroke Council suggested guidelines for the medical and surgical management of spontaneous ICH [14]. Rather than attempting to set forward definitive treatment guidelines, their stated goal was to outline a reasonable approach for the treatment of ICH and identify questions for future study. Their medical management guidelines are based on four small randomized trials [23–26], several nonrandomized clinical series, and general principles of patient care in a neurosurgical intensive care unit. These strategies are primarily aimed at (1) blood pressure control, (2) intracranial pressure and cerebral perfusion pressure management, (3) maintenance of euvolemia, and (4) seizure prophylaxis. Similarly, their surgical management guidelines are based on four randomized trials (reviewed here) and several nonrandomized clinical series. The authors suggest that patients with hemorrhages less than 10 cm^3, minimal neurologic deficits, or a GCS score less than or equal to 4 are poor candidates for surgical ICH treatment. Surgery should be considered in patients with ICH associated with a surgically accessible lesion (eg, AVM, aneurysm, cavernous angioma) and "…a chance for a good outcome…" In addition, they suggest that surgery should be considered in "young patients" with a "moderate or large" ICH who are clinically deteriorating. Because of the lack of definitive evidence, however, they conclude that the optimal therapy (ie, surgical or medical) for all other patients remains unclear.

Our approach to evaluating ICH patients takes several factors into account, the most important of which are age, site of hemorrhage, CT evidence of significant mass effect, and neurologic examination. Nontraumatic subcortical ICH is associated with several etiologic factors. Most common are amyloid angiopathy and hypertension. Other causes include malignancy, AVMs, coagulopathy, vasculitis, infection, and venous sinus thrombosis. Evaluation and surgical intervention should proceed with this differential diagnosis in mind.

Initially, we routinely assess head CT, coagulation parameters to rule out coagulopathy, and toxicology screens to rule out the effects of sedatives. Patients demonstrating CT findings typical of ICH hematoma morphology who are older than 50 years of age with a history of hypertension or older than 65 years of age with lobar hemorrhage and a history of dementia undergo no further imaging workup. All patients less than 50 years of age, older patients without a history of hypertension or vascular disease, and all patients with atypical hematoma morphology or greater than expected parenchymal edema undergo gadolinium-enhanced

MRI with magnetic resonance angiography. CT angiography is obtained in patients with normal renal function if MRI is contraindicated, if MRI would be prohibitively time-consuming, or if the patient is hemodynamically unstable. If abnormal enhancement suggesting tumor is observed, craniotomy is considered, at which time a biopsy is taken. If abnormal vessels suggesting AVM or cavernoma are observed, patients undergo a cerebral arteriogram.

In our experience, patients with putaminal or thalamic ICH do not demonstrate significant improvement in mortality or neurologic outcome when compared with those treated with medical management alone. Exceptions to this include relatively young patients without major comorbidities who exhibit rapid neurologic deterioration from admission GCS scores of 13 to 15 to GCS scores of 5 to 8 after hospitalization. If such a patient has a nondominant-hemisphere putaminal hemorrhage, no major ventricular extension, and significant mass effect demonstrated on CT not caused by hydrocephalus, we consider craniotomy a reasonable option.

Most of our operative interventions are on nondominant-hemisphere subcortical ICH patients less than 60 years of age with few medical comorbidities, a hematoma volume of greater than 10 cm^3, significant mass effect demonstrated on CT, and a GCS score of 5 or greater. Patients with dominant-hemisphere subcortical ICH lesions judged not to encroach on eloquent cortex meeting these criteria are considered surgical candidates. Patients with dominant-hemisphere hematomas near or involving eloquent cortical structures are seldom considered for surgical intervention because of the risk of postoperative aphasia and the likelihood of a poor outcome.

The goals of surgical ICH management are to reduce hematoma-associated mass effect and potentially secondary neuronal injury while minimizing further brain injury during evacuation. Mass effect may cause local damage from prolonged compression of surrounding parenchyma, leading to edema and ischemia. ICH may also cause a more extensive and diffuse mass effect significant enough to produce increased ICP and, potentially, transtentorial or subfalcine herniation. If the goal of surgery is to relieve local mass effect, hematoma removal may be helpful if the lesion is in an accessible location. If the hematoma is in an inaccessible location (eg, posterior putamen, thalamus, dominant-hemisphere temporal or posterior frontal lobar hemorrhage), however, there may be some benefit of relieving the more global mass effects causing increased ICP or herniation. For these reasons, we have occasionally performed hemicraniectomy for patients with putaminal, thalamic, or dominant-hemisphere lobar hemorrhages in whom resection presented a high risk of causing further deficits. Because early evacuation may reduce secondary hematoma-induced brain injury [27–29], we operate as soon as possible in patients with accessible lesions once any coagulopathy is corrected and the patient is medically sufficiently stable to undergo surgery.

Summary

Based on currently available literature, there is no definitive evidence to support decisions about which ICH patients should be managed surgically and which should be managed by medical therapy alone. Furthermore, when surgical ICH management is undertaken, there is no definitive evidence to suggest which procedure is indicated under different circumstances. Additional randomized controlled trials are needed to provide this evidence.

Currently underway, the International Surgical Trial in Intracerebral Hemorrhage is a randomized controlled trial designed to determine if early surgical removal of ICH is superior to initial conservative management [30–32]. As of July 2001, 668 patients from 65 centers had been randomized to this trial. The investigators plan to enroll 1000 patients so as to achieve adequate statistical power. Preliminary results revealed that the median patient age was 65 years and that most patients were randomized within the first 24 hours of ictus. The presenting GCS scores ranged between 5 and 15, with the scores of half of the patients being greater than 10. Fewer than 15% of all patients had a favorable outcome based on the Glasgow Outcome Scale. No data are available on mortality rates or other outcome measures. Comparisons between the two treatment groups await the trial's conclusion.

Future randomized controlled trials are clearly needed. A sufficient number of patients should be enrolled to assess the affects of patient age, comorbidities, hematoma volume, hematoma site (including dominant versus nondominant hemisphere), presenting neurologic examination, timing of surgery, and different surgical procedures (eg, craniotomy, craniectomy, stereotactic needle aspiration, stereotactically guided endoscopic evacuation). Trials designed specifically to compare different surgical methods would be helpful.

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