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Endoscopic Evacuation of Acute Subdural Hematomas: A New Selection Criterion

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Abstract

Introduction Acute subdural hematomas (ASDHs) have a high mortality rate and unfavorable outcomes especially in the elderly population even after surgery is performed. The conventional recommended surgeries by the Brain Trauma Foundation in 2006 were craniotomies or craniectomies for ASDH. As the world population ages, and endoscopic techniques improve, endoscopic surgery should be utilized to improve the outcomes in elderly patients with ASDH.

Materials and Methods This was a single-center retrospective report on our series of six patients that underwent endoscopic ASDH evacuation (EASE). Demographic data, the contralateral global cortical atrophy (GCA) score, evacuation rates, and outcomes were analyzed.

Results All patients' symptoms and Glasgow Coma Scale improved or were similar after EASE with no complications. Good outcome was seen in 4 (66.7%) patients. Patients with poor outcome had initial low Glasgow Coma Scale scores on admission. The higher the contralateral GCA score, the higher the evacuation rate ($r = 0.825$, $p \leq 0.043$). All the patients had a GCA score of ≥ 7.

Conclusion EASE is at least not inferior to craniotomy for the elderly population in terms of functional outcome for now. Using the contralateral GCA score may help identify suitable patients for this technique instead of just using a cut-off age as a criteria.

Keywords
- elderly
- endoscopic
- acute subdural hematoma
- criteria
- functional outcome
- local anesthesia

Introduction

Acute subdural hematomas (ASDHs) have a mortality rate as high as 60%.[1,2] The treatment guidelines for ASDH by the Brain Trauma Foundation were written two decades ago in 2006 but did not include a recommended age limit.[2] Many studies have shown that surgery will likely not benefit elderly patients with initial low Glasgow Coma Scale (GCS) <9 and signs of herniation since most report near 100% poor outcomes.[3–6] In a study on geriatric traumatic brain injury in Japan, it was found that the overall mortality rate was 71% and unfavorable outcome was 87% at 6 months after injury.[7]

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Even though this rate is discouraging, the same study found that surgery reduced rates of unfavorable outcome (84 vs. 93%) and mortality (66 vs. 86%) compared to those managed without surgery.[7] Another study showed a similar unfavorable outcome rate of 78% in operated ASDH.[8] These dismal reports likely represent the outcome of previous more invasive techniques. Current recommended indications for surgery in patients with ASDH are those greater than 10-mm thickness or those with a midline shift greater than 5 mm regardless of GCS.[2] It was recommended that a craniotomy or craniectomy be used for clot evacuation.[2] The problem with conventional surgeries is the large amount of blood loss, tissue trauma, and general anesthesia (GA), all of which are poorly tolerated by the older generation. With an increasingly healthy and independent older population as a result of global health care advances, making these difficult decisions for the elderly are becoming common. We owe our patients and their families the best options that provide the best benefits and the least risks. As a neurosurgeon's armamentarium expands especially in the area of endoscopic surgeries, these minimally invasive techniques may benefit the older population and further improve the favorable outcome rates. A total of 13 centers have reported their experience with endoscopic ASDH evacuation (EASE) with promising results. The mortality rate ranged from 0 to 40% and poor outcome ranged from 3.6 to 73.3%.[9] To date, there is still no clear objective guide as to when EASE can be employed instead of conventional surgeries. In order to address this dilemma, we propose an unprecedented selection criterion by brain computed tomography (CT) contralateral global cortical atrophy (GCA) score. We report our series of six patients who underwent EASE with an emphasis on advantages in the elderly population, and the contralateral GCA score in aiding patient selection for a successful EASE.

Materials and Methods

This is a single-center retrospective observational study at our center from January 2022 to April 2023. All included patients had undergone EASE, GCS ≥ 9 with reactive pupils initially, ASDH >10 mm or midline shift ≥ 5 mm, or were symptomatic. Patients with congenital coagulopathy, intracerebral hematoma, or burst lobes were excluded. Hemostasis for these patients would be difficult using only endoscopic techniques and usually portend a higher risk of severe cerebral edema hindering passage of the endoscope in the subdural space. Patients on anticoagulants or antiplatelets were not excluded and they underwent surgery once optimized. Data of patients that have undergone EASE were collected from computerized records and brain CT. Age, sex, comorbidities, chief complaints, mechanism of injury, antiplatelet and anticoagulant use, mode of anesthesia, operative complications, preoperative and postoperative GCS, Glasgow Outcome Scale (GOS) on discharge, hematoma evacuation rate, and contralateral GCA score were collected.

All EASE were performed by two consultant neurosurgeons at our center with extensive experience in endoscopic surgeries. Local anesthesia (LA) with controlled sedation was the method of choice using lignocaine, bupivacaine, pentazocine, and propofol. Patients were in supine positions with the ipsilateral shoulder elevated and head turned to the contralateral side. The head was supported with a horseshoe head rest. Linear or sigmoid skin incisions were made to allow a craniotomy size of 3 cm over the thickest part of the hematoma. Dura was opened in a cruciate manner. The ASDH was evacuated with a 30-degree lens 4-mm rigid 13 cm endoscope and malleable suction cannula. Angled bipolar forceps with lengths of 12 and 15 cm and oxidized cellulose were used for hemostasis. The ASDH was meticulously removed under direct endoscopic visualization taking care to achieve hemostasis each time a bleeder was encountered. The entire cerebral convexity was inspected systematically in a circumferential manner till satisfactory evacuation was achieved. The ASDH was evacuated to the surgeon's discretion and once done, a passive subdural drain was left in situ. The bone flaps were replaced back and skin closed with staplers. The subdural drains were removed after the postoperative CT brain scans were reviewed.

The ASDH evacuation rate was calculated as:

$$\textit{volume of ASDH after surgery} \div \textit{volume of ASDH before surgery} \times 100\%$$

ASDH volume was estimated by assuming that the SDH is half an ellipsoid using the formula[10,11]:

$$\textit{Width (ASDH thickness)} \times \textit{length} \times \textit{height} \div 4$$

We assessed the degree of cerebral atrophy using the GCA score by Pasquier et al.[12] The original score assesses 13 regions. First, cortical sulci GCA score at frontal, parieto-occipital, and temporal areas. Second, ventricle GCA score of the frontal, parietal-occipital, temporal, in each hemisphere, and the third ventricle. Each region is given a score from 0 to 3. No cortical atrophy equals a GCA score 0, mild atrophy (opening of sulci) a GCA score 1, moderate atrophy (volume loss of gyri) a GCA score 2, and severe atrophy (knife blade atrophy) a GCA score 3. Similarly for the ventricles, a score of 0, 1, 2, and 3 are given for no, mild, moderate, and severe widening of the ventricles. The total GCA score ranges from 0 (no atrophy) to 39 (maximum atrophy).[12] For this study, we only used GCA score on the contralateral cortical hemisphere, contralateral ventricles, and third ventricle as the ipsilateral hemisphere GCA score and ipsilateral ventricles GCA score cannot be accurately assessed due to mass effect from the ASDH. Thus, for the "contralateral GCA score" for these seven regions, the minimum score was 0 and maximum score was 21.

Results

There were a total of six premorbidly independent patients that underwent EASE, five males and one female. The age range was from 56 to 92 years old. Patients' summaries are depicted in ►**Table 1**. All patients were symptomatic, had at least one comorbidity, and successfully completed EASE

Table 1 Details of patients that underwent endoscopic evacuation of acute subdural hematomas

Case no.	Age/sex	Comorbids	Presenting complaint	Mechanism	Antiplatelet and anticoagulant	SDH thickness (mm)	Midline shift (mm)		Volume (mL)		Rate of evacuation (%)	GCA	Complication	Initial GCS	GCS postoperation and condition	GOS
							Preop	Postop	Preop	Postop						
1	81/M	DM, IHD	Reduced consciousness, left hemiplegia MRC 2/5, fever	Fall at home	Aspirin	14	4	2	38.8	3.3	91.5	9	None	E4V2M5	E3V4M5 Improved deficit	2
2	56/M	Leukemia	Expressive aphasia, right hemiparesis MRC 4/5	Spontaneous Pancytopenia	None	12	2	0	11.1	2.7	75.7	7	None	E4V4M6	E4V5M6 Improved deficit	5
3	69/M	IHD, CCF, HPT	Unable to ambulate due to unstable left lower limb	Fall at home	Clopidogrel	8	2	1	11.7	4.9	58.1	7	None	E4V5M6	E4V5M6 Improved deficit	5
4	80/M	AAA, stroke, aortic valve replacement, IHD, COPD smoker, prostate cancer, HPT	Dysphasia, drowsiness.	Fall many times	Warfarin. INR 2.59 on admission. INR 1.6 before operation	10	5	2	5.3	0.7	86.8	10	None	E4V4M6	E4V5M6 Improved deficit	5
5	92/F	HPT, dementia	Confusion, right upper limb fracture	Fall at nursing home	None	10	0	0	10.8	4.1	62.0	8	None	E4V4M6	E4V4M6 Confusion less later on	4
6	84/M	DM, HPT, dementia	Aphasia, left hemiparesis MRC 3/5	Fall at nursing home	Aspirin	8	2	0	11.9	0	100	13	None	E3V1M5	E3V1M5	2

Abbreviations: AAA, abdominal aortic aneurysm; CCF, congestive cardiac failure; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; F, female; GCA, global cortical atrophy; GCS, Glasgow Coma Scale; GOS, Glasgow Outcome Scale; HPT, hypertension; IHD, ischemic heart disease; INR, international normalized ratio; M, male; MRC, Medical Research Council; SDH, subdural hematoma.

Table 2 Pearson's correlation coefficients (r) of contralateral global cortical atrophy score and evacuation rate

Variable	Mean (SD)	r	p-Value
Contralateral GCA score	9.0 (2.28)	0.825	0.043
Evacuation rate	79.0 (16.70)		

Abbreviations: GCA, global cortical atrophy; SD, standard deviation.

under LA. Fall was the mechanism for ASDH in five patients and one ASDH developed spontaneously due to pancytopenia from a newly diagnosed leukemia. Only two patients were not on antiplatelet or anticoagulant. All midline shifts and ASDH volume were reduced. The rate of evacuation ranged from 58.1 to 100%. Their contralateral GCA scores ranged from 7 to 13. There were no complications perioperatively. All patients had improved or similar GCS and deficits upon discharge. The two (33.3%) patients with poor GOS are those with poor GCS during admission.

An interesting finding is that the higher the contralateral GCA score, the higher the evacuation rate. Inspection of scatter plots between GCA score and evacuation rate showed homoscedasticity, therefore a Pearson's correlation was run on the data. The results showed a significant positive correlation between the two variables, $r = 0.825$, $p \leq 0.043$ (►**Table 2**). This supports our intraoperative experience whereby patients with higher GCA scores allowed better visualization and easier evacuation of the ASDH since there was more space between the brain and dura.

Illustrative Case

Case 1

This was an 81-year-old gentleman with underlying diabetes mellitus and ischemic heart disease on aspirin. He had a fall and was brought to the hospital with reduced consciousness, left hemiplegia, and fever. His initial GCS was E4V2M5 with equal reactive pupils and a left hemiplegia with power of 2/5. A CT brain was done revealing a right convexity ASDH of 14-mm thick causing a 4-mm midline shift to the left. The calculated preoperative ASDH volume was 38.8 mL. His contralateral GCA score was 9 based on the preoperative

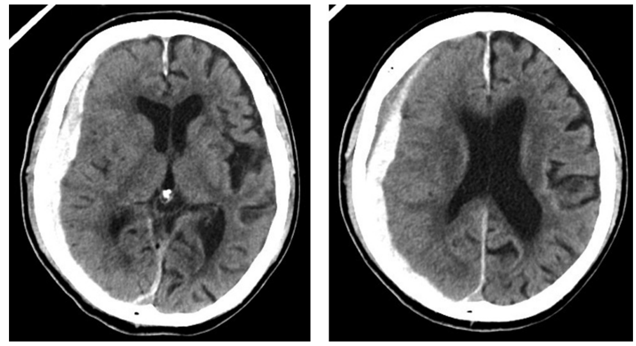

Fig. 1 Preoperative brain computed tomography of an 81-year-old gentleman that sustained a right acute subdural hematoma after a fall. The calculated contralateral global cortical atrophy score was 9.

CT brain (►**Fig. 1**). He underwent emergency EASE under LA and sedation via a small linear incision and craniotomy (►**Fig. 2**). ►**Video 1** illustrates the intraoperative view, technique of clot evacuation, and hemostasis. Operative room setup is shown in ►**Fig. 3**. The monitor position is located on the opposite side of the craniotomy and the endoscope is held by the surgeon. The other hand holds the malleable sucker or bipolar. There was no complication from the surgery, and right after surgery, his GCS improved to E3V4M5. The postoperative CT brain showed marked reduction of ASDH and the calculated postoperative ASDH volume was 3.3 mL making the evacuation rate 91.5% (►**Fig. 4**). We unfortunately do not have further follow-up details as he was transferred to another hospital for further treatment of newly diagnosed coronavirus disease pneumonia. Upon transfer, his GOS was 2.

Video 1

This intraoperative video of case no. 1 depicts the basic surgical steps for endoscopic evacuation of acute subdural hematomas. Online content including video sequences viewable at: https://www.thieme-connect.com/products/ejournals/html/10.1055/s-0044-1787101.

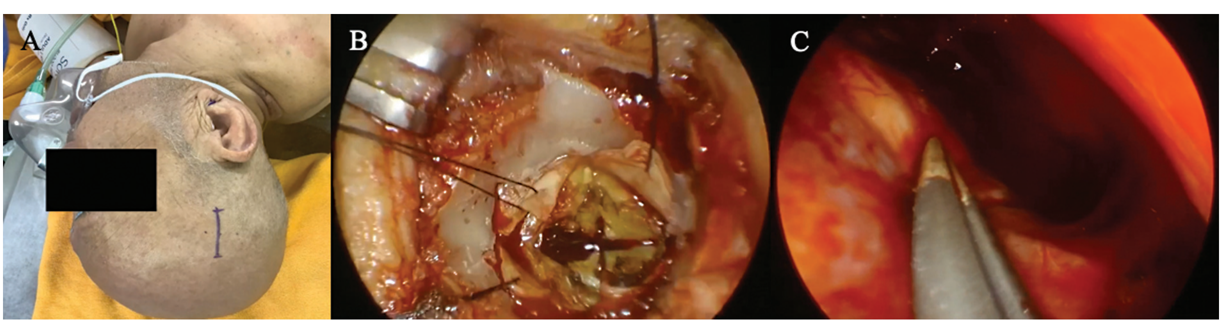

Fig. 2 An 81-year-old gentleman with acute subdural hematoma. (**A**) Surgery was done under local anesthesia and sedation via a small linear incision and small craniotomy. (**B**) Intraoperative picture showing the craniotomy and dura that has been opened in a cruciate manner. (**C**) Bipolar coagulation was used to achieve hemostasis under direct vision with a 30-degree endoscope.

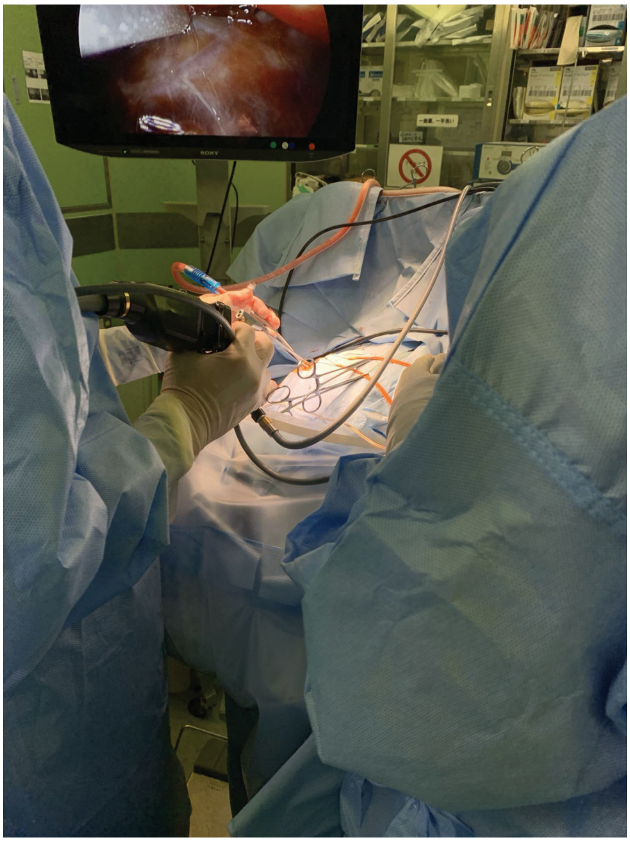

Fig. 3 Operative room setup. The monitor position is located on the opposite side of the craniotomy and the endoscope is held by the surgeon. The other hand holds the malleable sucker or bipolar.

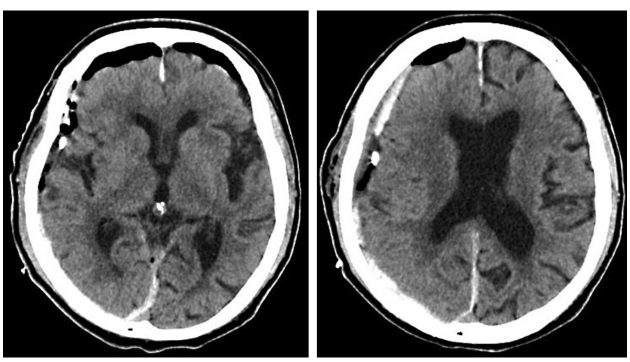

Fig. 4 Postoperative brain computed tomography of the 81-year-old gentleman after endoscopic acute subdural hematoma evacuation. The calculated evacuation rate was 91.5%.

Discussion

Global Cortical Atrophy Score as a Selection Criterion

Multiple studies have arbitrarily set a minimum age as a selection criterion for suitability to undergo EASE. Spencer et al suggested an age >80 years old,[9] while Yokosuka et al accepted a lower age of >70 years old.[13] Brain atrophy evaluation using the GCA score may help decide the suitability of patients for EASE instead of relying on age as an arbitrary marker for cerebral atrophy. As in our series, case no. 2 successfully underwent EASE although he was 56 years old. His contralateral GCA score was 7. An even younger 31-year-old with underlying schizophrenia and epilepsy with cerebral atrophy was reported by Kuge et al to have also safely undergone EASE.[14] From the images provided, that patient's contralateral GCA score was also 7. It is not possible to propose a cutoff value of the contralateral GCA score where EASE should not be done for now, but it may be reasonable to propose from our experience that cases with GCA score of ≥7 regardless of age can safely undergo EASE.

Advantage for the Elderly in Terms of Timing of Surgery

Servadei et al reported that all patients with an initial hematoma thickness greater than 10 mm required surgery.[15] It is known that timing of surgery for ASDH is crucial to improve outcomes for all ages of patients.[16] Shimoda et al reported that early surgery for ASDH in the geriatric population within the first 4 hours after injury had better outcomes.[7] Having said that, in the elderly population with an atrophic brain, ASDH greater than 10 mm may be tolerated compared to younger patients and some centers have opted for delayed burr hole and drainage once the clot liquidifies.[17] The main concern of initial nonoperative management is the risk of neurological deterioration and need for close monitoring.[18] There is no clear answer as to whether this strategy is better compared to early surgery. In fact, there is an ongoing RESET-ASDH trial addressing outcome of surgery versus conservative management in patients ≥65 years old with ASDH.[19] In some patients with ASDH with GCS 13 to 15 that did not require surgery initially, 35% needed delayed clot evacuation with a median of 17 days after trauma.[20] This goes to show that even patients with good GCS need close monitoring as they may deteriorate in 2 to 3 weeks. In this period of time, complications such as orthostatic pneumonia, nosocomial infections, urinary tract infection, deep venous thrombosis, pressure ulcers, and complications from withholding of antiplatelet or anticoagulants may arise with a reported rate of 28 to 44%.[17,21] The other downside to initial conservative management is the prolonged hospital stay and costs that averaged 28 days.[17] So the question remains as to whether earlier endoscopic surgery would be able to prevent these potential complications and allow for earlier return of activity and resumption of medications.

Advantage in the Elderly in Terms of Avoiding General Anesthesia

Common complications associated with a large craniotomy and craniectomy for ASDH include new intracranial hematoma, hydrocephalus, wound breakdown, and cerebrospinal fluid leak.[22,23] Larger craniotomies will also lead to more blood loss, tissue disruption, and it is not possible to perform it under LA. The smaller craniotomies and skin incisions are also advantageous in terms of blood loss, since the elderly population is more likely to be on anticoagulants and antiplatelets. In a recent study by Mahmood et al, minicraniotomy under LA had lower complication rates and shorter intensive care unit stays compared to GA.[24] GA portends a greater risk to elderly patients because of a decrease in physiologic reserve to respond to stress. Geriatric patients have decreased tachycardic response and impaired baroreceptor reflexes resulting in inability to maintain cardiac output during hypovolemia from blood loss.[25] Calcified blood vessels decrease compliance and result in labile blood pressure in response to GA and hypovolemia.[26] These together with higher incidence of coronary artery disease in the elderly put them at high risk of myocardial infarction. Elderly patients have a high risk of pneumonia owing it to poor immune systems and difficulty clearing secretions especially after use of opioids and neuromuscular blocking agents.[27] Anesthetics may impair cerebral autoregulation in the elderly leading to higher risk of stroke.[28] These patients also easily become hypotensive during induction and hypertensive during laryngoscopy.[29]

Limitations

This early analysis with only six patients is definitely too small to make any definitive conclusions. However, even with this small number, a clear significance is seen. Ideally, all surgeries should be performed by a single surgeon as evacuation rates may be surgeon-dependent. We did not manage to get long-term follow-up data for recurrence rates as most of our patients were transferred to other centers for further care. In the future, prospective studies on more patients will help clarify these limitations.

Conclusion

EASE is at least not inferior to craniotomy in terms of mortality or functional outcome for now. Future studies may show if it is superior for the elderly population with cerebral atrophy. Using the contralateral GCA score may be used to help identify suitable patients for this technique instead of just using a cutoff age as a criterion.

Note

The authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this article. All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. For this type of study formal consent is not required.

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Conflict of Interest

None declared.

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