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Single Frontal Burr-Hole Craniostomy Under Local Anesthesia for Treating Chronic Subdural Hematoma in the Septuagenarians and Older Adults: Surgical Technique and Results

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Abstract

Background Chronic subdural hematoma (CSDH) is not a totally benign disease in the elderly patients, especially those aged 70 years and above. Hence, the surgical treatment of CSDH in aged patients needs to be as minimally disruptive as possible.

Methods An annotated description of the surgical technique of single frontal burr-hole craniostomy performed under local anesthesia and without closed tube drainage for evacuating CSDH in the septuagenarians and older adults is given. We also review the outcome of the procedure on a prospective consecutive cohort of patients in our service

Results Thirty patients, 25 males, aged 70 years and above successfully underwent this surgical procedure. Their mean age was 76.5 years (standard deviation, 4.3). The CSDH was bilateral in 30% (9/30), and more left sided in the rest, the unilateral cases, and was of mixed density radiologically, in most cases (73%, 22/30). Clinical presentation was mainly gait impairment, cognitive decline, and headache, and 57% (17/30) presented with coma or stupor as assessed by the Markwalder grading scale. The surgery was successfully executed in all, median duration 45.0 minutes (interquartile range 37.3–60.0), and solely under local anesthesia in 77% (23/30) or with momentary short-acting sedation in the rest. The outcome was very good in 90.0% (27/30) using the modified Rankin Scale (mRS) including two-third (20/30) completely asymptomatic (mRS 0) and 7/30 with only slight symptoms/disability, mRS $\leq$ 2. Three patients died perioperatively, all presenting in coma.

Conclusion This surgical technique appears very effectual for CSDH, is executed at a comparatively low cost, and, being much less disruptive than other traditional methods, may be a more homeostatic operative treatment in geriatric patients at least.

Keywords
- chronic subdural hematoma
- burr-hole craniostomy
- single frontal burr-hole
- local anesthesia
- geriatric patients

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Background

Non-acute subdural hematoma, or chronic subdural hematoma (CSDH), is a neurosurgical presentation that is easily treated by a very simple operative paradigm. But it is a condition that is likely to be seen more frequently in the elderly, accounting for up to 58/100,00 of people aged 70 years (the septuagenarians) and above in the West.[1,2] In contrast, patients with CSDH from sub-Saharan Africa and other developing countries of the world are usually much younger, with the mean age in recent years being approximately 50 and 60 years.[3–6] The neurosurgical operative treatment of CSDH ranges from the complex undertaking of major cranial openings with or without membranectomy, through burr-hole craniostomy, to the very simple cranial trephinations, including bedside twist drill craniostomy or even bedside subdural tapping with the Aoki needle.[7–13]

However, partly because of existing comorbidities (as well as frailty) that are not infrequently associated with these senior citizens, CSDH is not a benign disease in the elderly as such.[9,14] Therefore, it is of some practical necessity to choose operative techniques that are not only effectual but are also as minimally disruptive as possible in the very aged patient population with this condition. The operative procedure of single frontal burr-hole craniostomy performed under local anesthesia and without subdural tube drainage is the technique we deploy in our service for this condition in the elderly patients aged 70 years and above.

In this report, we present this surgical technique as a simple, intuitive, minimally disruptive, and even low-cost operative treatment for non-acute subdural hematoma in this not-infrequently frail geriatric patient population.

Methods

We present an annotated description of the surgical technique of single frontal burr-hole craniostomy performed under local anesthesia, and without subdural drain, for CSDH, followed by a descriptive analysis of its use in a consecutive cohort of patients. In the initial phase of the development of this surgical technique in our practice, we conveniently selected the cases that presented in extremis for this procedure.[15] Usually, these were frail, elderly patients presenting with coma or with significant comorbidity. But, as a matter of fact, we have since found, as time passed by, that this technique can be used even in almost all cases of CSDH.

Written informed consent was obtained from each patient or their close relations for the surgical operations. The Directorate of Clinical Services, Research and Training of the authors' institution gave a written approval for this study.

Surgical Technique

A scalp incision line of two-finger breadth is planned in the frontal region, usually around the hairline for those so blessed. The operative field is then scrubbed and prepped as usual. Next, scalp infiltration with a local anesthetic agent is made along the proposed incision line as well as along a concentric circle of scalp of about three-finger breadths to facilitate securing the op-site isolation draping with skin staples, ►**Fig. 1**. The scalp incision is developed down to the cranium, and a 20 mm or so burr-hole is placed. The dura is coagulated and opened generously for all the diameter of the burr-hole. Some of the subdural fluid, usually a little fraction, would gush out spontaneously following this, and then, a tube for evacuating the hematoma usually a 16F nasogastric tubing (NGT) is introduced, directed posteriorly to the parieto-occipital depth of the subdural fluid cavity. The tube must be introduced with only a two-finger grip and must not be forced, ►**Fig. 1**. Next, gentle suction pressure is applied to the NGT with a 10 mL syringe (or the like) until the subdural fluid begins to flow out, gravity aided, by capillary action. The suctioning is then stopped. The whole hemorrhagic content of the subdural space is, thus, emptied by sump into a bowl, ►**Fig. 2**. Using the operating irrigation bulb or syringe also with a curved "mouth," a thorough irrigation of the subdural space is then achieved, until clear, by introducing warm normal saline in all directions and allowing the subdural irrigation fluid to drain via the NGT still in situ, ►**Fig. 2e**. This is aided by gravity and occasional application of suction pressure to the external ostium of the NGT. The operative wound is then closed as usual.

The patients usually make such brisk recovery, many times on the operating table, that their in-hospital follow-up is usually only by the clinical course. Because of the severe resource constraints of our low-resource practice, acquisition of postoperative cranial CT, in-hospital or at out-patient follow-up, is not routine but dictated by clinical indications.

Clinical Materials

We performed a descriptive analysis of a consecutive cohort of our elderly patients, aged 70 years and above, who have undergone this operative procedure. This analysis includes the demographics (age, gender, and some pre-morbid clinical parameters), clinical presentation, the radiological characteristics of the hematoma, the surgical details, and the postoperative outcome.

Results

There were 30 cases, 25 males and 5 females, aged 70 years and above, with a mean age of 76.5 years (standard deviation, 4.3) for this analysis. Of these 30 patients, 16 cases (53.3%) were 75 years and above, while eight cases (26.7%) were 80 years and above.

►**Table 1** shows some of the radiological and clinical characteristics of the study subjects. The non-acute subdural hematoma was bilateral in 30% (9/30); the rest were unilateral, either right or left, with the left having a greater frequency, ►**Fig. 3**. Computed tomography (CT) scanning was the main radiologic diagnostic investigation in our patients; only two

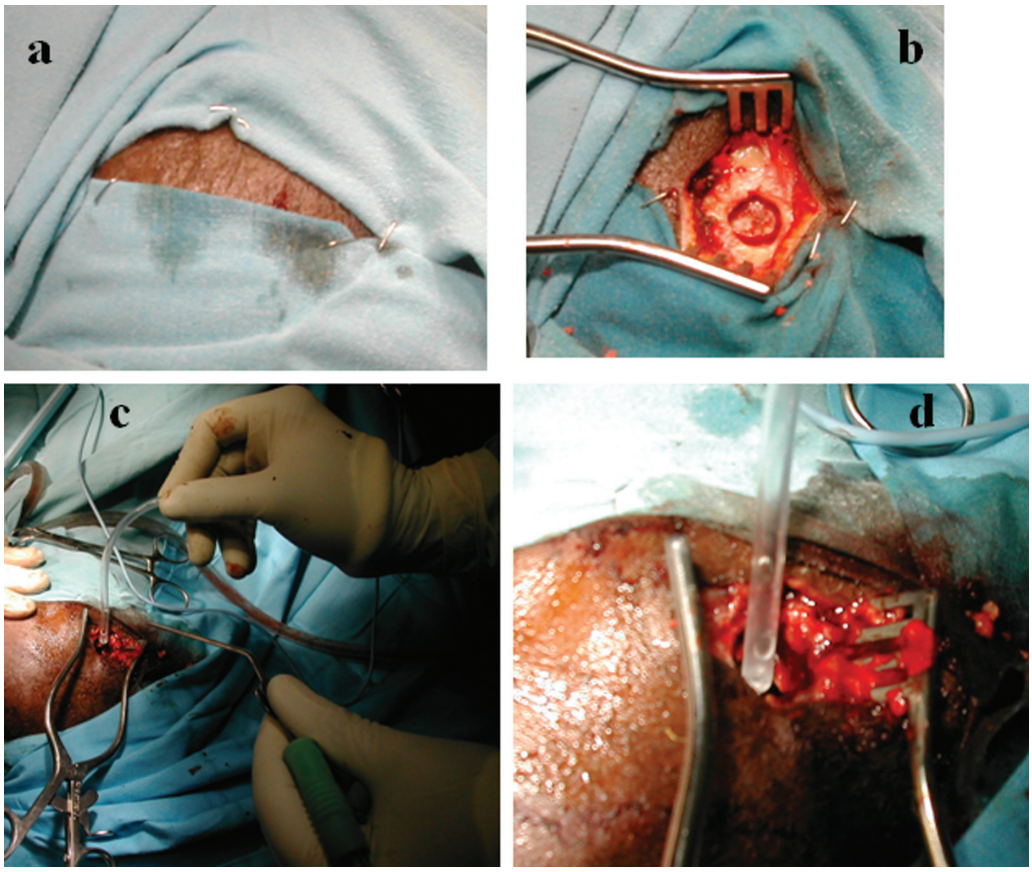

Fig. 1 Single anterior-frontal burr-hole evacuation of CSDH. (**a**) The operative site is chosen about the hairline, prepped, and draped, and local anesthesia is administered. (**b**) 2 to 3 cm burr hole is placed (**c, d**) following a generous durotomy involving the full extent of the burr-hole, a moderate-size NG tube, usually size 16F, is gently, two-finger-only-technique, introduced under direct vision into the subdural space and advanced down to its depth.

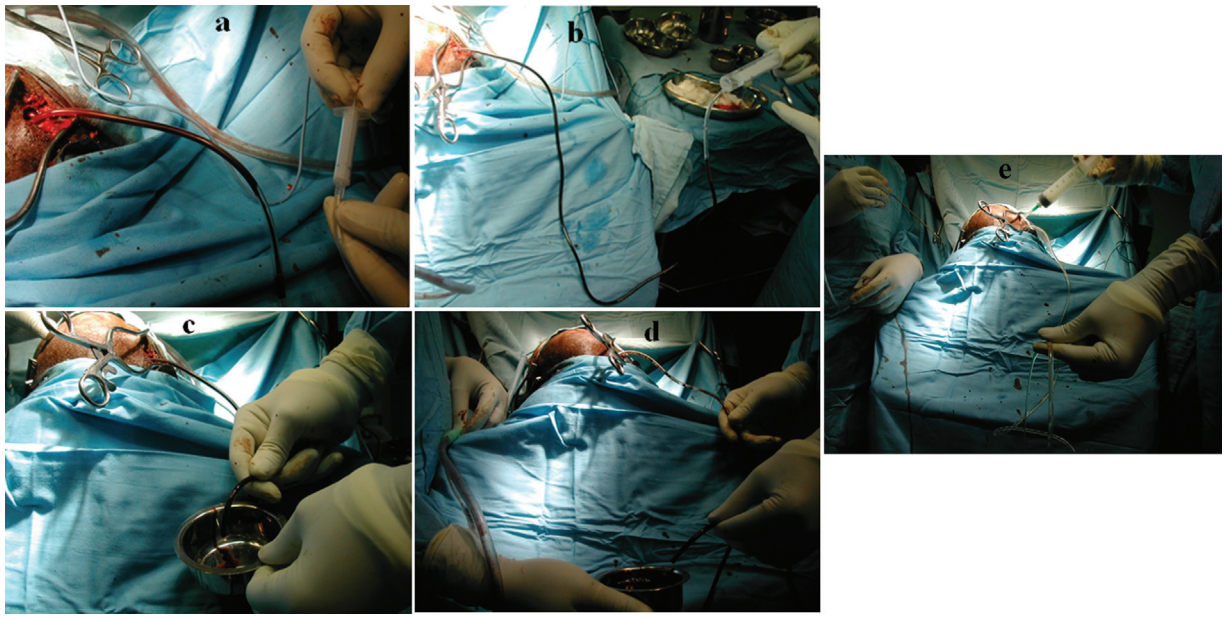

Fig. 2 (**a, b**) Gentle syringe-suction pressure is applied on the external end of the nasogastric tube (NGT) until enough blood column is reached by the tube to promote the capillary flow of the blood. (**c**) The syringe is withdrawn and the blood flows out spontaneously by capillary action aided by gravity. (**d**) All of the subdural fluid is emptied this way in a controlled manner into a receiver (inset). (**e**) Warm irrigation fluid is introduced via the same burr-hole by the side of the NGT into the four quadrants of the subdural space. The fluid also empties spontaneously until clear (arrow) by capillarity and gravity via the NGT. The evacuation tube is then removed and the wound is closed in the usual way.

Table 1 Clinical and radiological characteristics of the geriatric patients treated with this surgical technique

Clinical-Radiological Characteristics	Number (%)
Laterality of subdural hematoma	
Right	9 (30)
Left	12 (40)
Bilateral	9 (30)
Type of subdural by CT density	
Hypodense	5 (16.7)
Mixed density	22 (73.3)
Isodense	3 (10.0)
Presenting Symptoms	
Gait impairment	29 (96.7)
Cognitive decline	25 (83.3)
Headache	23 (76.7)
Loss of consciousness	19 (63.3)

patients got magnetic resonance imaging scans and these were usually for those for whom other neurological diagnoses (including brain tumor or stroke) were suspected by the primary-care physicians/neurologists before referral for neurosurgery. Radiologically the hematoma on CT was of mixed density in 73% (22/30), and in the rest, it was hypo- or isodense. ►**Fig. 4** shows one of the cases of bilateral CSDH operated with this surgical technique.

Similar to publications from other parts of Africa, and developing countries,[3,4,6] preceding history of trauma was obtained in 18/30 (60%) of our patients. Most presented with gait impairment, cognitive decline, and headache, ►**Table 1**, and as shown in ►**Table 2**, as many as 17/30 (56.7%) presented with stupor or coma as assessed with the Markwalder grading scale.[16] Some 40% (12/30) had background history of hypertension and three were on low-dose (75 mg) aspirin treatment; 10 (33.3%) had their initial clinical diagnosis as cerebrovascular accident. History of alcohol ingestion was obtained in only 2/30; none had coagulation disorder.

The surgery was successfully completed in all, median duration 45.0 minutes (interquartile range [IQR] 37.3–60.0). It was performed solely under local anesthesia in 77% (23/30); momentary sedation with bolus doses of Propofol, a short-acting agent, was added in the rest for occasional intraoperative restlessness. There was not any episode of intraoperative adverse events. The postoperative recovery was brisk in most patients, and the median in-hospital stay before discharge was 7 days (IQR 5–11).

The outcome was very good in 83.3% (25/30) using the modified Rankin Scale (mRS) including two-third (20/30) completely asymptomatic (mRS 0) and 5/30 with only slight symptoms and no disability (mRS 1). Of the other five patients, two were mRS 2, with slight disability at discharge. Three patients died, all from those that presented with coma, ►**Table 2**. Postoperative CT scanning was acquired in only eight patients; usually for some concerning postoperative clinical issues. All the patients that were discharged home were followed up in the outpatient department, with the median duration of 3.5 months (IQR 2–12); some 70% of the total patient cohorts (21/30) have been followed up for more than 3 months.

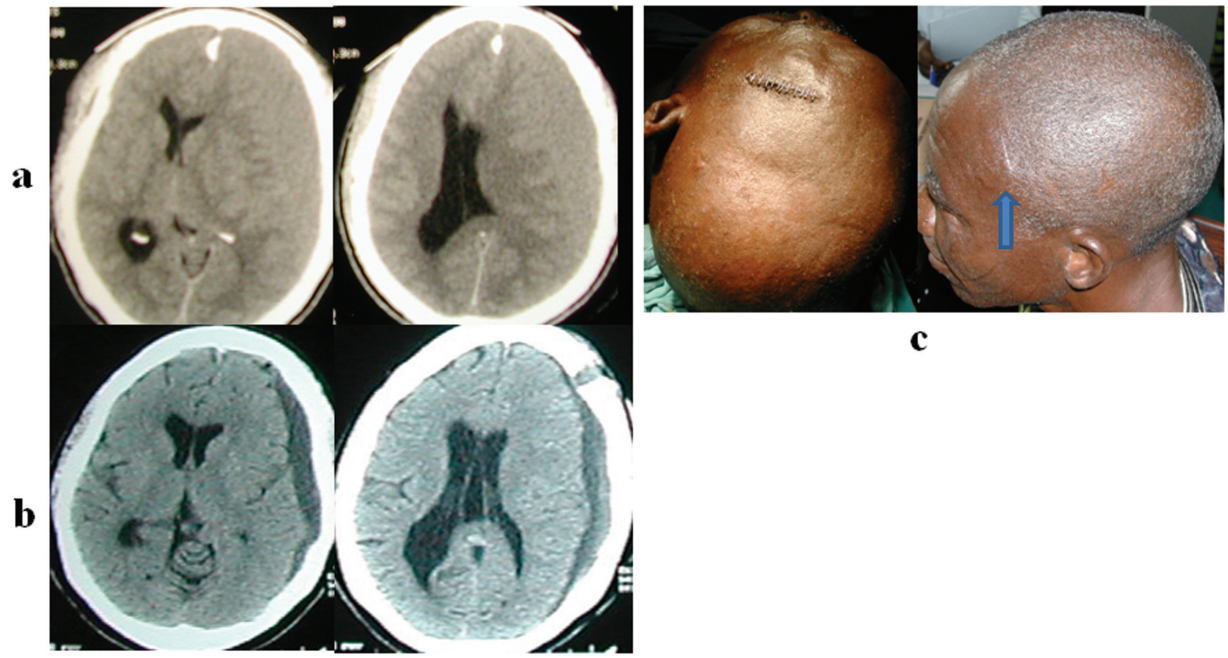

Fig. 3 An elderly man presented unconscious and had cranial CT scan (**a**) showing left-sided subacute subdural hematoma with marked mass effect; (**b**) cranial CT 5 days post-surgical evacuation via the left anterior-frontal single burr hole showing marked early postoperative resolution of the intracranial hypertension. The residual subdural collection is a well-diluted hygroma essentially. There is no pneumocephalus (**c**) surgical incision immediately postoperatively (left figure) and on the first clinic visit 4 weeks postoperatively (arrow, right figure).

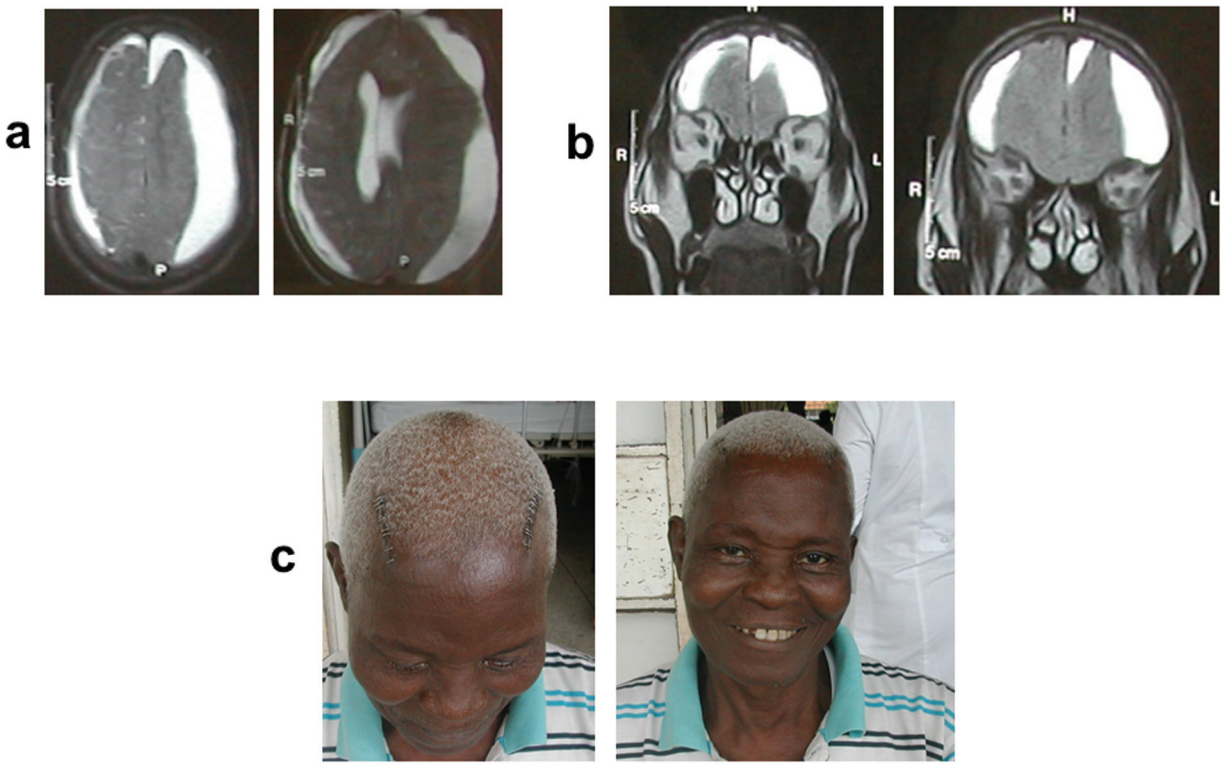

Fig. 4 A 78-year-old man was operated with this technique for symptomatic bilateral chronic subdural hematoma. The preoperative MRI cuts are shown in the (**a**) axial and (**b**) coronal cross-sections. (**c**) The patient, on postoperative day 7 when the wound staples were removed.

There were three cases of subdural hematoma recurrence, all ipsilateral and unilateral cases, in our study subjects.

One was actually a failure of the surgery, technically. It involved an 87-year-old man who presented with coma and was operated for a left-sided mixed-density CSDH with this technique. He made a brisk recovery postoperatively, wound staples were removed on postoperative day (POD) 6, and was being reviewed for possible in-hospital discharge after which his neurological status progressively declined again. Repeat brain CT on POD 13 revealed a persistent parietal hypodense collection, ►**Fig. 5**. In retrospect, this was merely the parietal loculation of the initial layered fronto-parietal collection which apparently was ensconced from the frontal subdural component by another capsule, ►**Fig. 5a**. At repeat surgery through the same left frontal burr-hole, the outer capsule of this ensconced parietal CSDH was merely sought and

Table 2 The clinical status of the patients, using the Markwalder grading scale, preoperatively and at in-hospital discharge

Markwalder grade	Preoperative	Discharge
0, no symptoms	–	23
1, mild symptoms	2	4
2, focal deficit	11	–
3, Stupor	9	–
4, Coma	8	–

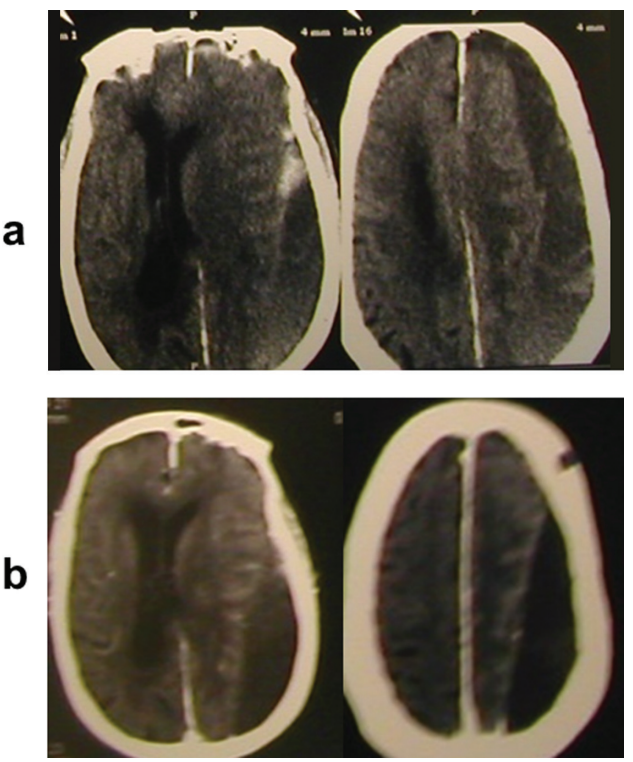

Fig. 5 An 87-year-old man was operated for (**a**) a left-sided layered CSDH of mixed density. He made initial brisk clinical recovery, then relapsed. (**b**) Repeat cranial CT on POD 13 showed the resolution of the frontal component of the initial lesion but a persistence of the parieto-occipital component.

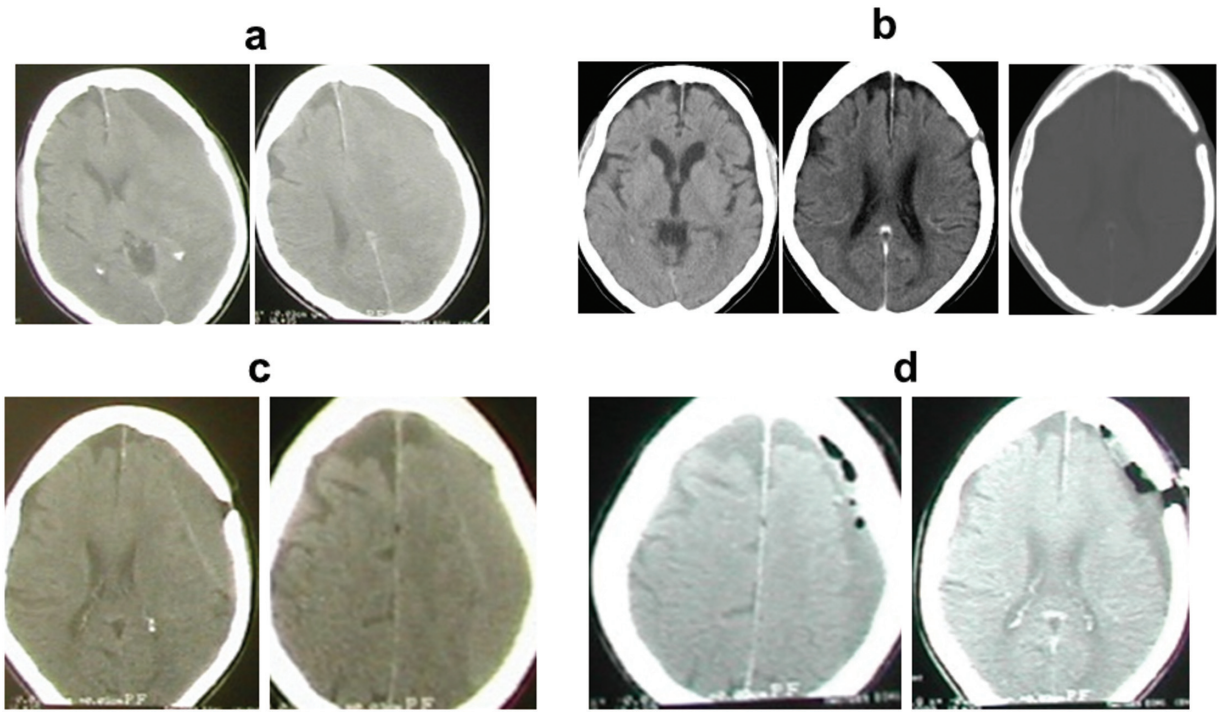

Fig. 6 An 82-year-old woman with a (**a**) left-sided mixed density CSDH made brisk clinical and (**b**) radiological recovery from surgery. Two months later she showed clinical and (**c**) radiological evidence of recurrence. This was reoperated through the same left-sided single frontal burr-hole craniostomy under local anesthesia. She made another good clinical and (**d**) radiological recovery.

fenestrated generously; the content was emptied and the cavity irrigated until clear as usual. He thereafter made a brisk recovery and was discharged home in the excellent clinical state (Markwalder 0, mRS 0), on POD 5. He remained well for some 6 years after that surgery. This was early in this surgical experience. We have since learnt to always seek out the inner-outer membranes of compartmentalized CSDHs, fenestrate them, and then irrigate them until clear in the subsequent years.

The next recurrence involved an 82-year-old woman who made a good recovery, mRS grade 0, from the first surgery (►**Fig. 6a, b**), but 2 months later showed clinical and radiological recurrence, ►**Fig. 6c**. She was re-operated through the same frontal burr-hole, had a good recovery, ►**Fig. 6d**, and in-hospital outcome, again, mRS 0, and was followed-up for 8 months in clinic before discharge.

The last case of recurrence in this series involved a 76-year-old man who recovered briskly from the first surgery and was discharged home, mRS 0, on POD 4, and was seen as an outpatient on POD 10 for stitch removal but, then, represented on POD 16 with clinical and radiological recurrence. He was re-operated with a good recovery, mRS 1, too.

Discussion

The operative treatment recommended for CSDH in standard neurosurgical texts ranges from the extreme to the very simple. The former includes especially "aggressive large craniectomy and stripping of neomembranes"[17,18] and the latter, much less invasive procedures like burr-hole craniostomy, twist drill craniostomy[19–22] with or without the use of the Subdural Evacuating Port System,[23] or percutaneous subdural tapping using the Aoki needle.[7] Out of all these surgical techniques, burr-hole craniostomy, usually double but occasionally single, appears to be the most common technique among neurosurgeons worldwide. Traditionally, this involves the placement of a 10 to 20 mm trephination in the frontal and parietal skull ipsilateral to the hematoma. It is performed usually in the operative room under general anesthesia.[9,24]

Each of the above surgical techniques has its proponents, and this is one of the main reasons for the perennial controversy surrounding the neurosurgical management of CSDH. But whatever the surgical procedure preferred by each operator, the goals for the operative treatment of non-acute subdural hematoma are fairly straightforward: decompression of the brain parenchyma via the removal of the space-occupying subdural hemorrhagic collection, as well as dilution, and inactivation of the endogenous fibrinolytic agents that osmotically serve to propagate the space-occupying increment in the volume of the residual subdural fluid.[1,17]

The surgical technique presented in this report achieves this purpose, combining the simplicity of execution with low cost and an especially more homeostatic surgical and anesthetic exertion on the not-infrequently frail patients, the very elderly population for whom it was devised in our practice. It also very effectively affords the opportunity for generous irrigation, until clear, of the subdural space we do not place a subdural drain post-hematoma evacuation, nor have need for any unnecessary postoperative CT imaging to follow the resolution of the hematoma.[25] A single burr-hole

placed under local anesthesia is so close to being so minimally invasive that most of our patients make brisk recovery right on the operation table. The frontal location is chosen so as to reduce to the barest minimum the amount of intracranial air following generous subdural irrigation during the procedure, ►**Fig. 6d**. This helps preempt the possible complication of tension pneumocephalus.

There are several previous reports of single burr-hole craniostomy for the operative treatment of CSDH.[17,26–30] But some of them are either designed to be performed under general anesthesia,[9,31] or are usually placed at the epicenter of the intracranial collection, somewhat posteriorly about the parietal region, that the risks of post-procedure intracranial pneumocephalus are higher,[17] or do not include the means for the total evacuation of the subdural hematoma or for the generous irrigation of the subdural cavity like our own. Most such procedures, thus, deploy subdural drains[7,16,24,30] and are usually CT-intensive for postoperative monitoring for recurrence.[17,30]

With the same goal of operative simplicity of single burr-hole for CSDH, the procedure described by Benzel et al[17] comes close to ours in a similarity of execution. It is a single burr-hole, also augmented with a red-rubber tube cannulation of the subdural space for evacuating the hematoma, and multi-quadrant subdural space irrigation. They also do not use postoperative subdural drain. However, their own burr-hole is not exactly as frontal as ours. Hence, it needs some neck manipulation to prevent pneumocephalus (which was impossible in one of their patients with cervical spondylosis and who was, thus, complicated with symptomatic pneumocephalus). They also performed their own procedure under general anesthesia. We have recently indicated that general anesthesia costs up to 10 times that of local anesthesia for neurosurgical operative procedures in our practice.[32]

Pearls and Pitfalls

Most of our patients tolerate this surgical procedure well. Occasionally, a patient may have moments of restlessness and/or blood pressure elevation. These are usually mitigated with the administration of one or two boluses of appropriate doses of the short-acting sedative, Propofol. Occasionally, there might also be a patient that does not hold the head still in the surgical position during the scalp infiltration of the local anesthetic, before the full operative field draping. For these, a yet-to-be-scrubbed surgical assistant can help hold the patient's head in position till the injection of the local anesthesia is administered. Such patients are usually calm thereafter.

One of the main features of this surgical technique is the introduction of the NGT into the subdural space to help ensure near-complete evacuation of the usually dirty (engine oil) subdural space contents in CSDH. This is the exact point where the most-to-be-feared complication of this surgical technique can happen. There is a possibility of brain penetration/laceration during the introduction of the NGT into the subdural space. In most cases of CSDH, however, the subdural collection creates enough room, extra-axial, for the safe introduction of the tube in the first instance, and the brain re-expansion is usually slow enough to permit multiple exits and re-introduction of the NGT into different quadrants of the subdural space as deemed appropriate for a more complete brain washing. But in the occasional case where brain re-expansion is brisk after the evacuation of the subdural fluid following the initial introduction of the NGT into the subdural space, one must need to restrain from the further attempt(s) of cannulation of the subdural space to avoid this pitfall of brain penetration/laceration. By keeping constant vigilance for this complication, we have, mercifully, not encountered it in any of our patients so far, including even the much younger patients in whom we also now carry out the procedure.

In addition, the initial suction pressure that is applied to the free end of the intracranial NGT used to achieve complete irrigation of the hematoma cavity must be very mild and only to last just to the point of initiating the flow of the hematoma fluid out of the tube. The rest of the fluid will drain by capillary action under gravity. Otherwise, one risks suction pressure injury to the brain

Limitations

In all, this report is still limited by the fact of it being a single-surgeon report, as well as one without a control arm to the study subjects. Also, the number of the study participants could certainly be larger than what is. However, the smallness of the series actually merely reflects the highly selected nature of the patients, the septuagenarians and older adults, for whom we first used the technique as reported here. We have since found out that most, if not all, patients (young or old; strong or frail) can actually safely undergo this surgical procedure for CSDH. It is, as a matter of fact, now our de-facto technique for this surgery and a subject for a prospective cohort study.

Conclusion

The technique of single frontal burr-hole craniostomy under local anesthesia and without post-operative tube drainage presented in this report is an effectual, less-invasive, and low-cost treatment for CSDH and may be a more homeostatic technique to adopt in the usually frail geriatric patients in particular.

Ethics Approval and Consent to Participate

A letter of request for the audit of the senior author's operative surgical records in this report was stamped approved by the Directorate of Clinical Services, Research and Training of the authors' university teaching hospital, the University College Hospital, Ibadan. Although a reference number was not applicable for this letter of approval, a copy of the letter was uploaded as supplementary material during submission. Each patient or their relatives gave written informed consent for the surgical procedures described in this report

Consent for Publication
Written consent for publication was obtained from the patients whose identifying images are shown in this report.

Authors' Contributions
A.O.A. is responsible for conceptualization, methodology/surgical technique evolution, manuscript drafts through all the stages, project supervision, approval of the submitted version. B.I.U. is responsible for data curation, analysis, manuscript drafts, and approval of the submitted version. Both the authors have read and approved the manuscript.

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Conflict of Interest
None declared.

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