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Technical Notes

Endoscopic evacuation of septated chronic subdural hemorrhage – Technical considerations, results, and outcome

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ABSTRACT

Background: Chronic subdural hematoma (cSDH) is a common entity in the elderly. Homogeneous or well-liquefied CSDH has a standard line of treatment through burr hole and irrigation. However, the management of septated chronic subdural hematoma (sCSDH) with multiple membranes does not have a well-defined surgical approach. The neomembranes forming septations prevent evacuation of clots through burr holes, and the small remaining loculi with clots will enlarge overtime to cause recurrence.

Methods: Patients with sCSDH were operated through a minicraniotomy (2.5 cm × 2.5 cm) using rigid endoscopes for visualization of the subdural space. Using endoscope, the entire subdural space can be visualized. The neomembranes are removed with standard neurosurgical microinstruments. The entire cavity is irrigated under vision to remove all clots and ensures hemostasis.

Results: Eighty-three endoscope-assisted evacuations were done in 68 patients from January 2016 to April 2020. Fifty (73.5%) patients had unilateral and 18 (26.5%) had bilateral subdural. Only 1 patient (1.47%) had a clinically significant recollection of subdural bleeding 1 month after the procedure. Over a mean follow-up period of 25.3 months (range 1–53 months), rest of patients did not show any recollection.

Conclusion: Endoscopic evacuation of sCSDH is a safe and effective method and can be used to improve clot evacuation, and remove neomembranes under direct vision to reduce the rates of recollection. This method also obviates the need for larger craniotomies to remove membranes.

Keywords: Chronic subdural hemorrhage treatment, Endoscopic chronic subdural surgery, Minimally invasive chronic subdural surgery, Septated chronic subdural surgery

INTRODUCTION

The optimal therapeutic strategy for chronic subdural hematoma (cSDH) has remained an enigma, despite years of research. High recurrence rates up to 70% with 10–20% requiring a second surgery[15] are a testament to this fact.

There are many underlying factors which may lead to recurrence, but the presence of thick septations is perhaps the most important.[2] In septated chronic subdural hematomas (sCSDHs), the clots in the subdural space become organized and develop fibrinous membranes with neovascularity and increased permeability. These septations can lead to multilobulated or multilayered hematomas. The presence of fragile vessels generated with neovascularization, leads to repeated microhemorrhages and expansion of the hematoma.[1]

While standard burr hole drainage and irrigation of subdural space are considered sufficient for the removal of homogenous cSDH, the presence of septations in sCSDH hinders the efflux of the hematoma fluid through one or two burr hole.[16] The septations lead to inadequate expansion of the brain parenchyma and obliteration of the subdural cavity, which is imperative to prevent recurrence. To prevent recurrence in sCSDH, membranectomy is considered essential using a craniotomy traditionally[2] and endoscope assisted in modern times.[14,16]

In this article, we describe our surgical technique and outcomes of endoscope-assisted membranectomy through a minicraniotomy.

MATERIALS AND METHODS

Patient population

The study was done from January 2016 to April 2020. The patients showing the presence of membranes within the subdural collection, on imaging studies are selected for this technique. Patients with nonseptated collections are operated through standard burr hole technique. The total number of patients was 68, with 60 (88.2%) patients being male and 8 (11.8%) being females. The mean age of patients was 68.8 years (range 34–91). Fifty (73.5%) patients had unilateral septated subdural and 18 (26.5%) had bilateral subdural. Twenty-seven (39.70%) patients were taking antiplatelets for various indications and one patient was on anticoagulants. The mean follow-up was 25.3 months (range 1–53).

Equipment

Endoscope – Karl Storz (Karl Storz SE and co., Tuttlingen, Germany) 0° rigid endoscopes, with diameter of 4 mm and length of 18 cm, connected to HD monitor is used for the intraoperative visualization.

Drill – Midas Rex Legend (Medtronic, Sofamor Danek, USA), with a 2.3 mm burr on straight handpiece is used for a small burr hole, and F2-B1 footed attachment for making the minicraniotomy.

Procedural details

The procedure is done under general anesthesia or monitored anesthesia care. The patient is positioned supine with a roll under the ipsilateral shoulder to help in rotating the head to the contralateral side. The head should be completely flat with the sagittal plane parallel to the floor. The layout of the operating room is shown in [Figure 1].

A narrow strip of hair is removed from the site of proposed incision. The incision is 5 cm long over the superior temporal line and runs from anterior to posterior. The skin is prepped and infiltrated with 10 ml of lidocaine 2% and epinephrine 1:100,000 solution.

The skin is incised and retracted with a self-retaining retractor. A burr hole is made using a 2.3 mm burr on the anterior end of the incision. Using this burr hole as the starting point, a 2.5 cm minicraniotomy is made using a high-speed drill. Dural edges are hitched up and dura mater is opened in a cruciate fashion. The dural flaps are everted and retained in this position using tacking sutures.

The membranes directly under the craniotomy site are gently dissected and removed under direct vision. Irrigation is done to remove loose clots in the cavity. At this stage, the 0° scope is brought in and an inspection of the cavity is done. The scope is held in the left hand of the surgeon and the right hand is used to hold the grasping forceps or to place the irrigation tubes under vision for intraoperative irrigation. The enlargement of the subdural space by the clots and membranes overtime provides enough space for the movement of the endoscope. The membranes visualized are dissected and gently peeled using angled grasper forceps under vision. Both the outer and the inner membranes are removed as much as safely possible under vision. Any significant neovessel visualized in the vicinity of the craniotomy can be coagulated and cut.

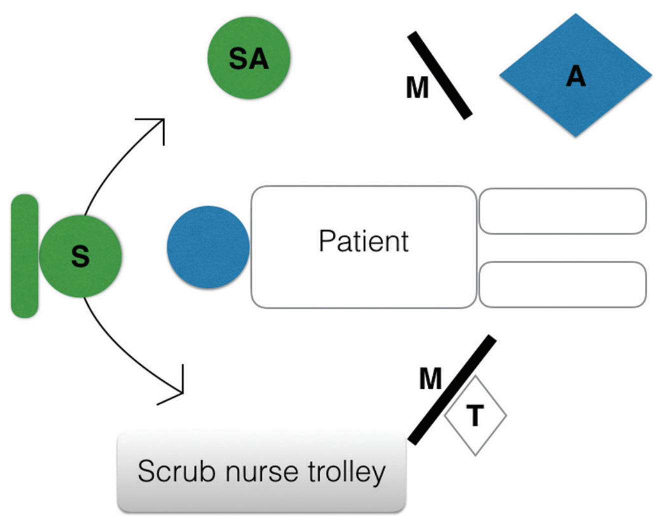

Figure 1: Layout of equipment inside the operating room. The surgeon (s) sits at the head end of the patient and can move as depicted by arrows to allow different angles for introducing the scope. The anesthesia machine (a) is at the foot end of the table. Two monitors (M] and the endoscopy tower (t) are directly in the line of sight of the surgeon. The surgical assistant (SA) needs to adjust position according to the position of the surgeon.

During removal of the membranes, some bleeding is always encountered. This bleeding in the deeper recesses can be stopped using irrigation with warm saline and placing some Surgicel (Ethicon, Johnson and Johnson, USA) over any raw surface. An irrigation tube with side holes can be introduced under vision to the far most edges of the subdural cavity and irrigated with warm saline to remove clots from the inaccessible areas of the cavity. The fogging of endoscope can be handled with irrigation. Copious irrigation not only helps in clearing the field of vision but also helps in hemostasis. After satisfactory membranectomy and hemostasis, a subdural drainage tube is put in the posterior dependent part of the subdural space. The dura mater is closed with a small pericranial patch graft. The bone flap is refixed with two titanium miniplates. Skin incision is closed in layers.

Postoperative care – Patients are extubated in immediate postoperative period and shifted to ICU for observation. The head end of the bed is kept flat and the patient is kept well hydrated. A plain computerized tomography scan is done on the 1st postoperative day. The drainage tube is removed if the drain output is <30 ml in 24 h. Most patients can be discharged by the 3rd postoperative day.

RESULTS

A total of 83 endoscope-assisted subdural evacuations were done during the study period. Fifty-three (77.9%) patients underwent unilateral procedure and 15 patients underwent bilateral procedures. The mean operative time was 157.5 min (range 90–240). The mean duration for keeping the subdural drain for postoperative drainage was 2.3 days (range 1–4) and for postoperative hospital stay was 4.48 days (range 3–10).

One patient (1.47%) had a recollection of subdural bleeding after a month of the procedure. This patient required re-exploration in view of progressive headaches. One patient (1.47%) expired 8 days after the procedure from congestive cardiac failure.

No infections or wound-related complications were seen in the study.

Index case

A 55-year-old female patient presented with holocranial headaches for 5 days and heaviness of the right side of body. The patient recalled a trivial fall at home around a month back. On examination, she only had mild right hemiparesis. On MRI, a left subdural septated hematoma was seen over the entire left cerebral convexity and causing midline shift to the right side [Figure 2a]. She was operated using the endoscope-assisted technique as described under general anesthesia. Intraoperatively, extensive septations were seen dividing the subdural hematoma into multiple cavities [Figure 2b]. The septations were broken with stripping of membranes under vision and the cavity was thoroughly irrigated [Video 1]. The surgery time was 140 min and her postoperative stay was 3 days. Her postoperative day 1 scan [Figure 2c], and follow-up scan after 1 year [Figure 2d] showed no recurrence of the subdural.

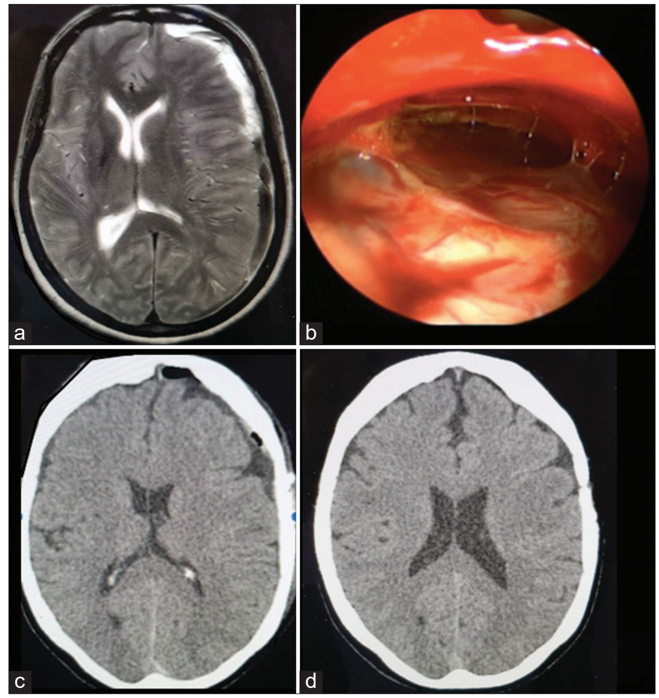

Figure 2: Images of a 55-year patient operated with the described technique. (a) The preoperative T2-weighted scan showing the septations in the subdural cavity with contralateral midline shift. (b) The endoscopic view of septations. (c) The postoperative day 1 CT showing good evacuation of clots and septa. (d) A 1-year follow-up scan showing good results.

DISCUSSION

cSDH invariably requires some form of a surgical intervention. This can be a twist drill craniotomy, burr hole drainage, or a craniotomy. The latter has been the traditional method of choice for sCSDH and for patients with recurrence. The most important complication in the treatment of cSDH remains recurrence of the hematoma. Even though the term "recurrence" is not clearly defined, it includes reaccumulation, persistence, postoperative rebleeding, or incomplete resolution of the operated hematoma.[11] When the recurrence is defined as a symptomatic reaccumulation of cSDH necessitating reoperation, the recurrence rate varies from 8% to 33%.[3]

There are many underlying factors which may lead to recurrence, but the presence of thick septations is perhaps the most important.[2] The septations lead to a multilobulated or multilayered appearance of the hematomas. A burr hole craniostomy will not lead to the drainage of all these lobulations, leading to inadequate drainage. That is why traditionally, a larger craniotomy is recommended for surgical drainage of these septated, loculated cSDH. Callovini *et al*.[2] advocated a larger craniotomy as a primary approach toward dealing with organized cSDH to reduce recurrence rates. Weigel *et al*.[13] reviewed 48 publications and came to a conclusion that twist drill and burr hole craniostomy should be considered as a first line of management, and craniotomy should be considered the treatment of last choice for recurrences. They also concluded that the postoperative outcome of chronic subdural hematoma has not improved substantially over the past 20 years.

Another important factor in preventing recurrence is re-expansion of brain after drainage of clot to obliterate the dead space of subdural cavity. Parenchymal re-expansion in sCSDH will happen once the septations and layered membranes are removed, a process called membranectomy.[4] The membranes are broadly classified into an outer and an inner membrane. The outer cSDH membrane is highly vascularized and exudation from macrocapillaries is critical in cSDH enlargement.[12] The inner membrane is usually thin, translucent, and relatively avascular. The inner membrane can be adherent to the underlying arachnoid over the cortical surface.[10]

Whether one or both the outer and inner membrane need to be removed, is a matter of debate. In our technique, we undertake removal of both outer and inner membranes. The role of the outer membrane in cSDH enlargement comes from its' increased permeability and exudative properties. The inner membrane is closely approximated to the brain surface and can prevent re-expansion of the brain. This forms the basis of a more thorough membranectomy in our approach.

Coagulopathy poses another challenge in the management of cSDH. As the life expectancy increases globally, more and more elderly patients would be using antiplatelets and anticoagulants for various indications. The use of anticoagulants not only increases the incidence of cSDH but also increases the risk of recurrence. Rust *et al*.[9] found that the risk of developing a cSDH was at least 42.5 times higher in warfarinized patients and the risk was also increased for patients on aspirin, although this risk could not be quantified. In our study, we found that the patients on anticoagulants would have thicker membranes and more organized clots. In this subset of patients, twist drill craniostomy or a burr hole craniostomy would invariably fail. A minicraniotomy and endoscope-assisted membranectomy are especially useful in such patients.

Karakhan in 1988[6] first described the use of an endoscope in visualization of the subdural space beyond the edges of a small trepanation. Since then, many surgeons have published their work with endoscopes in this condition.[5,8,14,16] Some surgeons prefer using a flexible system,[7] whereas others prefer a rigid endoscope.[14] Use of endoscope is now well established but still not widely practiced. We use a rigid endoscope system to visualize the subdural cavity.

There are certain distinct advantages while using an endoscope in draining sCSDH. A minicraniotomy of size 2.5 cm is only required while using an endoscope, as compared to a larger craniotomy required for conventional open approach. This reduces the morbidities associated with traditional approaches while achieving better results. Weigel *et al*.[13] did a systematic review of 48 publications and found higher morbidity with craniotomy as compared with both twist drill or burr hole craniostomy, and a nonstatistically significant trend of higher mortality with craniotomy. They suggested the use of craniotomy only as a last resort. Ducruet *et al*.[3] reviewed the topic in 2012 and performed a meta-analysis, whereby they found that craniotomy demonstrated a significantly higher mortality (12.2% compared with 3.7% for BHC and 5.1% for TDC).

The endoscope provides a clear visualization of the subdural space. The septations can be clearly seen and fenestrated. The endoscope can show a neovessel in the septations, which can be cauterized and cut.[14] The inner membrane is dissected with irrigation jet and gently peeled off. Certain parts of inner membrane that is adherent to the arachnoid can be left behind. The outer membrane can be easily stripped off the inner surface of the dura mater using a blunt dissector under view of a 30° rigid scope. The outer membrane is quite vascular and stripping it leads to bleeding. This can be controlled with copious irrigation or by placing small pieces of Surgicel over the raw surfaces. An irrigation tube can be placed in various parts of the subdural cavity under vision, so as not to injure the parenchyma. Normal saline is then passed through this tube to wash the clots out of the deeper recesses of the cavity. This is done till the effluent is clear and hemostasis is assured.

The ultimate treatment goals for cSDH are complete evacuation with no recurrence following surgical evacuation, while mitigating mortality and morbidity related to the natural history of cSDH and complications secondary to surgical intervention.[10] We believe that endoscope-assisted surgery for sCSDH helps in reducing the recurrence rates. This is because of breaking up of most, if not all loculations and removal of clots that are present much beyond the boundaries of the minicraniotomy. Using a flexible endoscope through a burr hole, Májovský *et al*.[7] reduced the recurrence rate to 8.8% in 37 endoscope-assisted surgeries. In a retrospective cohort comparison study, Zhang *et al*.[16] compared endoscope-assisted burr hole craniostomy and ordinary burr hole craniostomy in the treatment of sCSDH. There was no recurrence (0%) in the endoscopic group of

42 patients compared to the open burr hole craniostomy method which saw a recurrence rate of 25.8%. Morbidity was also significantly lower in the endoscopic group (4.8%) than in the open burr hole group (35.5%) ($P = 0.0121$). Our technique also excels in reducing the recurrence rates to a bare minimum. We had recurrence in a single patient (1.47%), which is quite significant. As per our knowledge, this is the largest study till date employing an endoscope-assisted technique for the evacuation of septated subdural hematomas.

From a technical standpoint, a few challenges do exist that prevent widespread use of endoscope-assisted cSDH surgery. First, it requires endoscopes and certain basic endoscopic skills. Endoscopes are not available in all neurosurgical departments. Second, neurosurgeons are not used to a 2D viewing system and need to adapt. Third, even though the surgery is not very demanding technically, it still has a learning curve. Neurosurgeons would need to learn to maneuver the endoscope and a second instrument through a small minicraniotomy without damaging the parenchyma.

Our study has certain limitations as well. This is a single-center, retrospective study with a single heterogeneous cohort of patients. There was no control group. Further studies are required to validate our findings.

CONCLUSION

Endoscope-assisted surgical evacuation of sCSDH is a safe and effective method. We believe that this technique has the potential to reduce the recurrence rates to a bare minimum. sCSDH treated with twist drill or a burr hole craniostomy has an unacceptably high incidence of recurrences. The scope of this technique can be further widened to treat subdural empyemas, epidural hematomas, and perhaps acute subdural and brain edema as well. We advise widespread use of endoscope-assisted evacuation of sCSDH in view of its low recurrence rates and low surgical site complications.

Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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