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Vascular

Membranectomy in organized chronic subdural hematomas: indications and technical notes

Giovanni Rocchi, MD[a], Emanuela Caroli, MD[a,*], Maurizio Salvati, MD[b], Roberto Delfini, MD[a]

[a]*Department of Neurological Sciences, Neurosurgery, University of Rome "La Sapienza", 00100 Rome, Italy*
[b]*Department of Neurosurgery, INM Neuromed IRCCS, Pozzilli (Is), 32945 Italy*

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Abstract

Background: The aim of the present study is to present our operative method of removing organized CSDHs and to structure the criteria for choosing this approach as first treatment.

Methods: Between 1991 and 1999 at our Institution, 14 consecutive patients with organized CSDHs required 16 craniotomies with membranectomy. They represent 5.8% of all patients (243) treated for CSDHs in the same period. All the patients had preoperative contrast-enhanced CT, and 9 patients also had contrast MRI.

Results: Initially, 9 patients underwent one burr hole or twist-drill hole. Of these 9 patients, 3 were treated at the same surgery with craniotomy and membranectomy as second treatment, 3 underwent a second burr hole and then membranectomy at the same surgery, and 3 patients underwent a second burr hole 3, 4, and 21 days after the first one and then membranectomy. Five patients underwent immediate craniotomy and membranectomy. There were no morbidity or mortality associated with this procedure. All patients had a full recovery without recurrence.

Conclusions: Contrast-enhanced MRI has greatly improved opportunities for discovering neomembrane before surgical intervention. We believe that MRI detection of thick and extensive membranes or solid clot with mass effect makes an immediate craniotomy to remove CSDH necessary.

Keywords: Chronic subdural hematoma; Magnetic resonance imaging; Membranectomy; Neomembranes; Organized chronic subdural hematoma; Surgical treatment

1. Introduction

Since 1857, when Virchow first described CSDHs as "pachymeningitis hemorrhagica interna," a vast variety of surgical techniques to treat this common disorder have been proposed [1]. There is a general agreement that a combination of clinical and radiographic findings, suggesting a CSDH with mass effect, indicates the surgical treatment [7,9,15,16,24,27,29,32,38,39,41,44]. Some authors support the use of minimal invasive intervention (burr hole or twist-drill holes) because these techniques offer equivalent efficacy to craniotomy with lower mortality and morbidity and a shorter operating time and hospital stay [6,24,38]. However, burr hole outcome varies widely with a percentage of reoperation from 3% to 37% [2,3,16,20,24,25,32,41-44]. These failures are due mainly to residual thick hematoma membranes [16,32,38,43]. The choice of the surgical technique to treat CSDHs must be dictated by the degree of organization of the hematoma. Burr hole and drainage is mandatory for nonseptated and mostly liquified CSHs. Conversely, craniotomy with membranectomy is the sole reasonable approach for CSHs organized in a solid structure.

We propose an easy technique of membranectomy that has guaranteed optimal results in our series of CSDHs.

However, the purpose of this report is not only to describe our operative method for treating organized CSDHs, but also to provide the criteria for selecting patients requiring craniotomy and membranectomy as first treatment.

Abbreviations: CSH, chronic subdural hematoma; CSDH, chronic subdural hematoma; CT, computed tomography; GCS, glasgow coma scale; MRI, magnetic resonance imaging; SDH, subdural hematoma.

* Corresponding author. Fax: +39 6 47888054.

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2. Material and methods

Between 1991 and 1999, 243 consecutive patients were surgically treated for CSDH at our institution. We have operated on only symptomatic patients. Our treatment of choice for chronic subdural hematoma is burr hole under sedation and local anesthesia with closed system drainage for 24 to 72 hours. However, 14 of our patients required craniotomy and membranectomy. This group of patients is the subject of the present study.

The admission status of each patient was classified according to the GCS score.

Computed tomography was the first imaging method for the evaluation of CSDH in all the patients. In the past, when CSDH showed radiological features of thick membranes, we perform craniotomy and membranectomy to remove the hematoma only after one attempt of evacuation by burr hole. In the last 3 years, we have adopted a new protocol to treat the organized CSDHs. We perform membranectomy as the first and unique treatment when an organized CSDH is radiologically documented.

3. Our protocol and surgical technique

For various years, we have removed organized SDH with a direct aggression on the hematoma membranes. However, over the last 6 years, we have adopted the following surgical procedure to perform a membranectomy.

Craniotomy limits are decided on the basis of the MRI. A large craniotomy flap is performed to expose the transition zone between external and internal hematoma membranes.

The dura is then opened and separated by the external membrane of the hematoma with a dissector. This is always a simple maneuver (Fig. 1A). Once the reflection zone of the hematoma and the adjacent cortical surface are well recognizable (Fig. 1B), we remove the hematoma by a gentle ject of physiologic saline solution (Fig. 1C). The deep membrane of the hematoma is progressively separated from an underlying arachnoid layer only by the water ject. This stratagem avoids any traction on the cortical surface (Fig. 1D). No attempt is made to remove by traction the membranes tenaciously adherent to the arachnoid surface or surrounding the bridge veins, but they are simply left in situ. In this case, the hematoma membranes are coagulated and cut.

4. Results

The patients included 7 men and 7 women. The mean age was 62.1 years (range, 41-76 years). Twelve patients had a history of minor head trauma occurring an average of 1.5 months before admission (range, 14 days-4 months). Previous head trauma was investigated via CT in 12 patients. One patient was dialyzed, and the remaining patients had no risk factors for the development of a CSDH. There were 7 patients with a GCS 10, 2 patients with a GCS 11, 2 patients with a GCS 12, and 3 patients with a GCS 13. The major symptoms at presentation were hemiparesis (12 patients), followed by aphasia (6 patients), and hyposthenia (2 patients) (Table 1).

All patients had CT at admission (Fig. 2A). Of the hematomas, 11 were dyshomogeneous, and 3 were homo-

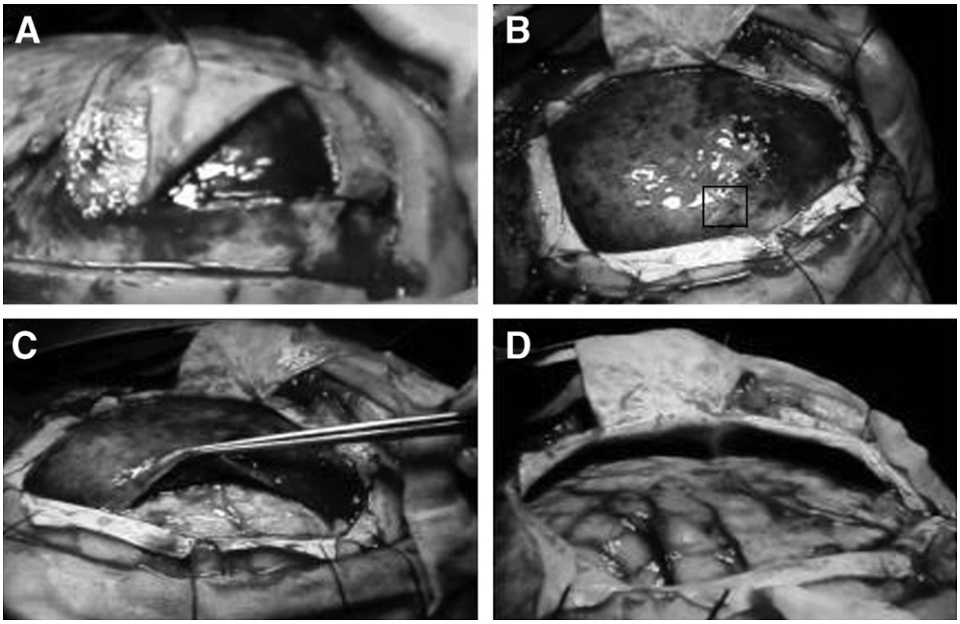

Fig. 1. Intraoperative images. A: The dura is separated from the underlying external hematoma membrane. B: The junction of the inner and outer membranes and the adjacent cortical surface are exposed (box). C: The CSDH is washed out by generous irrigation at reflection zone of the membranes. D: The CSDH has been removed.

Table 1
Clinical and radiologic features of our patients

Case	Age/Sex	History of head trauma	CT features at the time of trauma	CT features at the time of surgery	RM features
1	63/Female	No	Not performed	Bilateral and dyshomogeneous FTP hematoma with multiple compartments and hyperdense areas	Not performed
2	65/Male	Yes	Hygroma + fhc	Bilateral and dyshomogeneous FP hematoma with multiple compartments and hyperdense areas	Not performed
3	41/Male	Yes	Not performed	Homogeneous right FTP hematoma	Not performed
4	72/Female	Yes	Not performed	Dyshomogeneous right FTP hematoma with multiple compartments and hyperdense areas	Not performed
5	76/Male	Yes	Hygroma + fhc	Dyshomogeneous left FTP hematoma with septations	Multiple compartments with thick septations
6	65/Female	Yes	SDH	Dyshomogeneous right FP hematoma with septations	Multiple compartments
7	51/Female	Yes	Not performed	Dyshomogeneous right FP hematoma with septations and hyperdense areas	Multiple compartments with CE
8	62/Male	No[a]	Negative	Homogeneously hypodense left FTP hematoma	Dyshomogeneous organized hematoma with CE
9	72/Female	Yes	Negative	Dyshomogeneous left FTP hematoma with hyperdense areas	Multiple compartments
10	63/Male	Yes	Negative	Homogeneously hyperdense left FP hematoma	Not performed

FTP indicates frontotemporoparietal; fhc, frontal hemorrhagic contusion; FP, frontoparietal; CE, contrast enhancement.
[a] Dyalized patient.

geneous. Intrahematomal septations and hyperdense areas were documented in 10 and 8 hematomas, respectively (Table 1). Contrast MRI was performed in 9 cases (Table 1). Seven chronic SDHs were hypointense on T_1-weighted and hyperintense on T_2-weighted sequences. The remaining hematomas were hyperintense on both T_1- and T_2-weighted MRI images. In all contrast-enhanced MRI scans, the hematomas were divided into multiple layers and lobules by the intrahematomal membranes. These septations could be seen without contrast medium in 2 cases. In all cases, 2 layers were well detected: one layer was between the outer surface of the SDH and the cranial vault, and the other one was between the hematoma and the subarachnoid space. In all patients, the transition zone between the 2 membranes showed a triangular thickening (Fig. 2C).

Initial surgical procedure included burr hole in 6 patients and burr hole plus closed subdural drainage in 3 patients. Of the 6 patients, 3 had only one burr hole, and 3 had two burr holes before craniotomy that was performed at the same surgery. The 3 patients treated with burr hole plus subdural drainage underwent burr hole twice before craniotomy, which was performed 3, 4, and 20 days after last burr hole (Table 2). Five patients had an immediate craniotomy because of an important solid component detected by MRI (Tables 2 and 3). Two of the hematomas were bilateral. Hence, overall, we performed 16 membranectomies. Five membranectomies were performed with a direct aggression on hematoma membranes. The remaining 11 membranectomies were performed according to our new technique (Table 4).

Intraoperatively, 14 CSDHs consisted nearly completely of solid tissue with multiple layers, and 2 were completely solid, corresponding to the enhancement seen on MRI. Twelve patients made full and prompt recovery. Of the 4 patients who underwent a membranectomy with direct aggression on membranes (our previous technique of membranectomy), 2 had postoperative seizures and

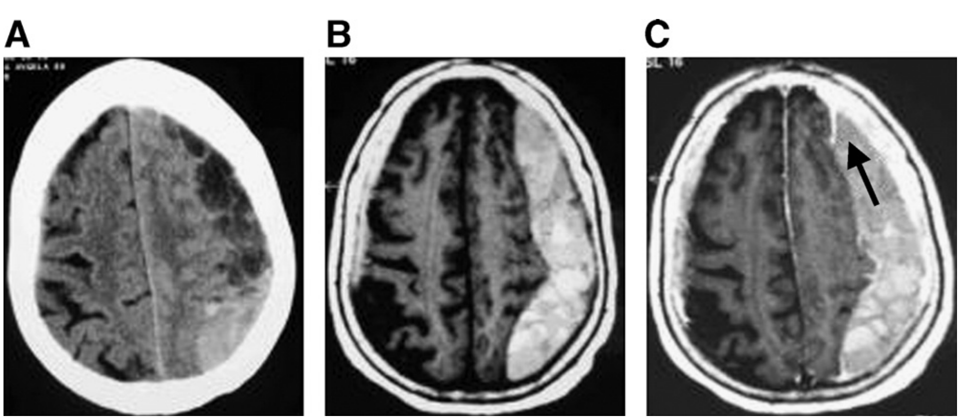

Fig. 2. A: Computed tomography showing intrahematomal septations. B: T_1-weighted MRI showing a hyperintense hematoma. C: Post contrast image evidences the outer, the inner membranes of the hematoma, and the transition zone between the 2 membranes (arrow) as a triangular thickening.

Table 2
Clinical features of our patient

Case	Interval from trauma to first operation	GCS at admission	Presenting symptoms
1	?	10	Aphasia, hyposthenia (left > right)
2	2 mo	12	Hyposthenia
3	2 wk	10	Left hemiparesis
4	20 d	10	Left hemiparesis
5	2 mo	11	Aphasia, right hemiparesis
6	1 mo	10	Left hemiparesis
7	4 mo	13	Left hemiparesis
8	Dyalized for some weeks	10	Aphasia, right hemiparesis
9	1 mo	10	Aphasia, right hemiparesis
10	1 mo	12	Aphasia, right hemiparesis

underwent antiepileptic therapy (Table 4). One patient with a large and very compressive CSDH had small hemorrhagic infarction that regressed completely. No patient had recurrence.

Because of rapidity of clinical results, patients who had membranectomy as first treatment had short postoperative hospital stay (mean, 6 days).

5. Discussion

Chronic subdural hematomas can be approached with several surgical techniques. The common treatment methods range from burr holes or twist-drill hole to craniotomy with removal of the hematoma thick membranes.

Actually, there is no uniform agreement on the best method to treat CSDHs [1,7,10,16,22,23,29,32,37]. The true problem, in our opinion, is to know preoperatively whether the CSDH is organized.

Contrast enhancement MRI may give useful information about the structure of CSDH [19]. This knowledge allows planning of the optimal surgical strategy.

Magnetic resonance imaging is not frequently used for the diagnosis of CSDH, but its superiority over CT is well demonstrated [5,28,31,35,36,40,44,45]. Magnetic resonance imaging evidences precisely the extension of SDH, facilitates the detection of CT-isodense SDH and small clot near the skull base and vertex, and often gives an accurate estimation of the age of SDH [19,34]. Furthermore, contrast-enhanced MRI may show the connective tissue reactions occurring during the maturation of SDH [11,19].

It is universally accepted that a subdural space does not exist [13,14]. The dura mater and arachnoid are attached to each other by means of a distinct layer of cells called dural border cells [13,14]. After trauma, blood or cerebrospinal fluid may collect and create a space within the dura border cell layer [13,14,21,46]. Once this intradural space has been created, the dura border layer is induced to proliferate and to produce a thin, continuous envelope of neomembrane around that space [33,38,43,46]. The composition of neomembranes is similar to a granulation tissue. Blood vessels, which are never found within the normal dura-arachnoid interface, are constant features of neomembranes. These vessels are fragile so that neomembranes undergo repetitive multifocal bleeding. The thickness of the neomembranes and the arrangement of their components vary greatly from case to case so that different densities of CSH can be found. In long-standing SDH, fibrous material increases gradually and reinforces the structure of the multiple intrahematomal neomembranes, forming a completely solid structure [12-14,17,19,33].

Magnetic resonance imaging has already been proposed as a basis for selecting the operative procedure for CSDH [44]. The rationale of this is based on the observation that MRI can evidence the intrahematomal structure of CSDH [44]. After contrast infusion, T_1-weighted images easily show the reactive tissues into the CSDH because of their high vascularity [11,19], then the CSDH with a multilayer intrahematomal structure becomes well detectable.

All our patients had CT, and 9 also had contrast-enhanced MRI. In all our patients, as already observed by others, contrast images show the transition zone between the

Table 3
Type and number of treatments

Case	First operation and outcome	Interval from BH and second operation	Second operation and outcome	Interval from second operation and third operation	Third operation
1	BH scarce drainage	At the same operation	Bilateral C,M excellent	/	/
2	Twist BH scarce drainage	At the same operation	Right C,M, right brain expansion, left septated hematoma	4 d	C,M
3	BH + CSD scarce drainage	8 d	BH-CT dyshomogeneous hematoma with multiple compartments	3 d	C,M
4	BH scarce drainage	At the same operation	Enlarged BH scarce drainage, thick membrane	At the same operation	C,M
5	BH no drainage	At the same operation	BH no drainage	At the same operation	C,M
6	Enlarged BH scarce drainage	At the same operation	C,M excellent	/	/
7	Parietal BH partial drainage[a]	At the same operation	Frontal BH solid hematoma	At the same operation	C,M
8	BH + CSD good drainage	4 d	CSD septated hematoma	4 d	C,M
9	C,M excellent	/	/	/	/
10	BH + CSD good drainage and discharge at sixth day	21 d, CT hyperdense SDH	BH + CSD discharge at eighth day	20 d	C,M

BH indicates burr hole; CSD, closed subdural drainage; C,M, craniotomy and membranectomy.
[a] Residue of the hematoma in the frontal site.

Table 4
Type of membranectomy and relative outcome, hospital stay, and follow-up

Case	Type of membranectomy	Outcome	Hospital stay	Follow-up
1	Partial, direct approach on membrane	Seizures	10 d	Good,6 mo (antiepileptic therapy)
2	Extensive, water ject resection	Good		Good, 6 y
3	Extensive, water ject resection	Good		Good, 7 y
4	Extensive, water ject resection	Extubed on third day, good	10 d	Good, 2 y
5	Extensive, water ject resection	Small frontal infarction (at the site of the contusion)	3 wk	Aphasia, 6 mo good, 1 y
6	Extensive, water ject resection	Good	8 d	Good, 1 y
7	Extensive, water ject resection	Good	11 d	Good, 6 mo
8	Partial, direct approach on membrane	Small frontal intraparenchymal hematoma, good		Good, 6 mo (antiepileptic therapy)
9	Partial, direct approach on membrane	Extubed on fifth day, good	12 d	Good, 1 y
10	Partial, direct approach on membrane	Good		Good, 6 y

outer and inner membranes of the hematoma as a triangular spandrel-like thickening [19,26]. This is consistent with the pathological studies that indicate the presence of fresh hemorrhagic foci and newly formed capillaries at the junction of the inner and outer membranes [26]. In addition, other radiological findings of our series were consistent with previous reports [4,18,35,40]. Intrahematomal multiple septations can be seen without contrast agent in only one third of the cases [19]. This occurred in 2 of 7 patients of the present series. This demonstrates the use of the contrast-enhanced MRI for visualizing organized SDH. We recommend that preoperative MRI be performed always in the following cases:

- Chronic subdural hematoma with unusual appearance on CT scans, such as presence of dyshomogeneous areas with high-density margins, multiple compartments, septations, and various bleeding foci
- Cases of recurrent CSH
- Enhancement of some portions of the hematoma and its membranes after contrast medium administration.

We followed the previously mentioned criteria to retain necessary MRI, and we have no false-positive cases, that is, cases in which MRI was done and did not prove the need for a craniotomy.

Failure of the treatment of CSDHs by burr hole evacuation is usually because of the presence of septations within CSDH producing noncommunicating compartments or to excessive formation of solid membranes [19]. The neuroendoscopic operative technique is safe and satisfactory for the treatment of septated CSDH [8]. This technique allows to excise neomembranes and achieve the efflux of the hematoma [8,19]. However, when contrast-enhanced MRI detects CSDH with completely solid membranes, endoscopy is not sufficient and a craniotomy should be primarily performed without attempt of using other approaches.

Craniotomy and removal of the membranes still carry a high rate of mortality and morbidity [4,8,18,30]. This is mainly because of the absence of a codified and universally accepted technique of membranectomy.

In the last years, we have used an easy technique for removing the CSDHs that has guaranteed excellent results.

Aggressive removal of membranes may evoke some problems such as postoperative convulsive disorder. This is because of arachnoid or brain damage by traction in the attempt of removing the membranes tightly adhering to the cortex. Therefore, hematoma removal by traction must be avoided.

Postoperative seizures requiring medical therapy occurred in 50% of our patients (2/4) who underwent a membranectomy by a direct aggression on the hematoma membranes. We advise performing a large craniotomy to expose the zone of reflection between outer and inner hematoma membrane. This stratagem allows not only a gentle and easy removal of the membranes by irrigation with a generous water ject, but also the removal of the zone of the membranes where capillaries had mainly developed. The membranes surrounding the bridge veins and the area of tenacious adherence between inner membrane and arachnoid surface must not be removed. In spite of in these particular conditions, we leave in situ the membranes; their removal is sufficient to guarantee the absence of recurrences.

We have obtained excellent results with the previously described technique and only one complication that regressed without neurological sequelae. This was the case of a patient with a small hemorrhagic infarction attributable to the decompression of a large CSDH rather than the surgical technique. In fact, the infarction was caused by the revascularization of hypoperfused cerebral areas compressed by CSDH. These hypoperfused areas in our patient were well detected by preoperative MRI.

6. Conclusion

Complete recovery obtained through a single operative procedure not only reduces surgical invasion but also lowers medical costs because of reduced hospital stay.

We believe that failure to recognize and properly treat organized CSDHs is the principal reason for the discordant results reported in the current literature. Craniotomy and membranectomy as first treatment have to be reserved only for selected cases: hematoma organized in solid structure, hematoma with multiple compartments delimited by thick membranes, and recurrent SDH with hemorrhagic foci previously treated with burr hole. In such cases, a gentle dissection of the membranes from cerebral surface is imperative to reduce the risks associated with this surgical procedure. Our strategy is to perform a large craniotomy to show the limits of the hematoma detected by contrast-enhanced MRI. Removal of the membranes by a saline solution ject at reflection zone of the hematoma avoids injuries to the underlying arachnoid surface and permits the removal of the area of the hematoma where there is a high density of newly formed capillaries.

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Commentary

The authors are to be congratulated for their thorough literature review and description of both the diagnosis and the effective and safe surgical method in the treatment of organized, membranized CSDHs. Their diagnostic use of contrast-enhanced MRI in questionable cases is also appropriate, and the illustrations are clear and cogent. As the authors have pointed out, this regimen applies to only the small subset of organized chronic subdural hematomas, specifically 14 of 243 or 5.8% of all their patients with CSDH. Nevertheless, any patient with evidence of dramatic multiloculation of a chronic SDH on CT scan could well benefit from a contrast MRI to ascertain the need for a more aggressive surgical approach ab initio. The surgical method itself is both effective and comparatively safe.

C. David Hunt, MD
Hoboken, NJ 07030, USA

In this series of 14 cases and 16 procedures, all had membranectomy: in 9 as a second operation and in 5 cases as a primary procedure. Obviously, in the first 9 cases, the second surgery became necessary because of the recurrence of subdural hematoma. All the authors favor membranectomy as the treatment of choice for chronic subdural hematomas. The CT and MR features of "dyshomogeneity" of the hematoma are considered as an indication for membranectomy with the possibility of thick membranes and septae within the hematoma and solid areas. In these cases, wide craniotomy was performed, and the membrane was separated with water jet dissection. This methodology is appealing, and the readers may also be tempted to go for this method. The authors have also pointed out that in areas where there was adherence, that part of the membrane was left in situ. Hence, the question of a total membranectomy does not arise, and one is doing either a partial or a subtotal membranectomy. The procedure involving a wide craniotomy is a major surgery. Is this procedure warranted? Considering the results as seen in this presentation with no mortality, it may be taken up. However, 50% of the cases had seizures complicating the issue, and lesser procedures also could give good results.

In our own large series of 2300 cases, we had to do membranectomy only in 6 cases. These cases had solid subdural hematomas, and the membranectomy became a concomitant process while removing the solid clots. All the other cases did well with subtemporalis marsupialization, with only 0.35 recurrences and 0.5% mortality.

Thus, it has to be concluded that membranectomy is not the only absolute method for treating chronic subdural hematomas, be it homogeneous or dyshomogeneous. Recurrent bleeds and the primary hematoma in various grades of degradation of blood elements give rise to variegated or dyshomogeneous appearance in the MRI or CT image. Yet, they are amenable for removal by irrigating out all the subdural collection and then performing subtemporalis marsupialization. If the septae are suspected within the hematoma, they can easily be divided via the endoscopic procedure.

M. Sambasivan, FAMS, FRCS
Department of Neuosurgery
Cosmopolitan Hospital
Trivandrum, Kerala 695011, India