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ORIGINAL ARTICLE

Fisher Grade and Lamina Terminalis Fenestration on Hydrocephalus in Patients with Bleeding Subarachnoidal Hemorrhage

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Abstract

Introduction: Incidence of shunt-dependent chronic hydrocephalus after aneurysmal subarachnoid hemorrhage (aSAH) is variable between 6% and 67%. LTF is an alternative intra-operative procedure which can be used in patients with aSAH which bleeds into ventricles. It allows the reorganization of the cerebrospinal fluid (CSF) circulation and decreases the CSF pressure and increases cerebral perfusion pressure. The aim of this study was to assess the short-term effects of LTF on hydrocephalus in patients with SAH.

Methods: 105 patients with a diagnosis of aSAH treated in Ümraniye Research and Training Hospital which underwent surgical clipping were included in our study. Some patients underwent LTF with an intraoperative decision. Our results were evaluated with regard to the presence of hydrocephalus, external ventricular drainage, and/or ventriculoperitoneal shunt need.

Results: 105 patients with aSAH were included in the study. According to first CT imaging of these patients, Fisher scores were given. Thirty-one patients had scored 1, 24 scored 2, 24 scored 4, and 26 scored 4. In 25 of 55 patients with Fisher Scores 1–2, LTF was applied, and shunt-dependent hydrocephalus was observed in two of them in the long term. In 38 of 50 patients with Fisher Scores 3–4, LTF was applied, and shunt-dependent hydrocephalus was observed in 16 of them.

Discussion and Conclusion: Risk of hydrocephalus in LTF-applied patients was lower in Fisher Grade 1–2 patients when compared to Grade 3–4 patients. LTF is an easy and efficacious procedure that allows cerebral relaxation before surgical clipping and decreases the risk of developing hydrocephalus after clipping. Since it decreases the risk of developing hydrocephalus both in lower and higher Fisher Grade groups, although the decrease in risk is more in lower grade group, we recommend that LTF should be applied.

Keywords: Fenestration; fisher; hydrocephalus; lamina terminalis; subarachnoid hemorrhage.

Aneurysmal subarachnoid hemorrhage (aSAH) is an important subgroup of cerebral hemorrhagic strokes with 2–32 cases per 100.000 population every year[1]. Most of the cases of SAH (>85%) are caused by ruptured aneurysms[2]. aSAH is a fatal condition, in which 15% of patients die at the scene of incidence and other 40% die in the following month[3]. To isolate the aneurysmal space from the parental artery, surgical clipping and endovascular coiling with or without stent placement can be done and are the choices of treatment.

Hydrocephalus is an emergent surgical condition which hampers the clinical improvement of SAH patients[4]. It can occur in the following hours acutely, or it can be a chronic complication[5]. Acute hydrocephalus basically occurs due

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to the obstruction of CSF circulation in the early hours, whereas the time course for chronic hydrocephalus is variable. In patients with acute hydrocephalus, external ventricular drainage (EVD) is done to divert the cerebrospinal fluid (CSF) flow outside of the ventricles. Most of these patients can tolerate clamping of the EVD before discharge, whereas 30% of them need permanent shunt applications.[6] Chronic hydrocephalus cases requiring shunt surgery is reported to be higher than 20%[7]. Thus, hydrocephalus is a common complication after aSAH. According to the recent studies, incidence of hydrocephalus after aSAH is between 17.2 and 31.2%[8]. Furthermore, hydrocephalus is an independent factor to predict worse functional long-term outcomes after aSAH[9]. Conventionally, ventriculoperitoneal shunt (VPS) is the treatment of choice after hydrocephalus.

Lamina Terminalis Fenestration (LFT) allows free CSF flow from third ventricle to basal cisterns. It is a procedure which allows the cerebrum to relax in the conditions of increased intracranial pressure, especially in surgical clipping of aneurysms. Furthermore, it allows better CSF circulation, clearing of blood in the basal cisterns and enhances CSF dynamics, thus preventing hydrocephalus[10]. Yaşargil is the first surgeon to apply LTF in anterior circulation as a part of neurovascular surgery[11]. LTF is an alternative intra-operative procedure which can be used in patients with aSAH which bleeds into ventricles. It allows reorganization of the CSF circulation, decreases the CSF pressure, and increases cerebral perfusion pressure[11,12]. The aim of this study to assess the short-term effects of LTF on hydrocephalus in patients with SAH.

Materials and Methods

105 patients with a diagnosis of aSAH treated in Ümraniye Research and Training Hospital that underwent surgical clipping of an aSAH were included in our study. Vital signs and consciousness of our patients were followed at a level one intensive care unit. Seizure prophylaxis was done with anti-epileptics, pain palliation was done with narcotic analgesics, and nimodipine was used to prevent vasospasm. In patients in with an aneurysm detected on diffusion subtraction angiography, imaging studies and operation were planned. Pre-operative hydrocephalus was treated with EVD. EVD was stopped before the operation and was continued intra-operatively, if required. According to post-operative CT scanning, EVD management was planned. Some patients underwent LTF with an intra-operative decision. If an LTF applied patient had and EVD, after clearing SAH, EVD was stopped, and ventricular enlargement was checked. If there was enlargement, a VPS operation was planned. Our results were evaluated with regard to the presence of hydrocephalus, EVD, and/or VPS need.

Radiologic Assessment

CT imaging was done at the time of admission, just after the operation and post-operative 48–72 h. In patients with rapidly deteriorating clinics, CT scans were done earlier.

Surgical Technique

Carotid and optic cisterns were dissected widely in both groups. Blood products in the ipsilateral Sylvian fissure and carotid cistern were cleared. Gyrus rectus resection was not done routinely and was only applied in cases where anterior communicating artery complex was not reachable with routine approaches. After opening carotid and optic cisterns, ipsilateral optic nerve was followed and dissected until reaching the frontal lobe. Then, frontal lobe was retracted, and lamina terminalis was seen. A 1 cm long incision of the avascular midline portion of lamina terminalis was done with a number 11 scalpel while securing neurovascular structures (Figs. 1 and 2). Patency of the perforation was proven with the observation of adequate CSF

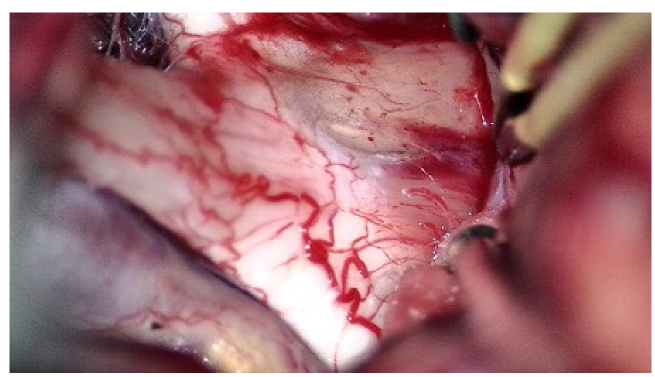

Figure 1. View of the lamina terminalis during surgery.

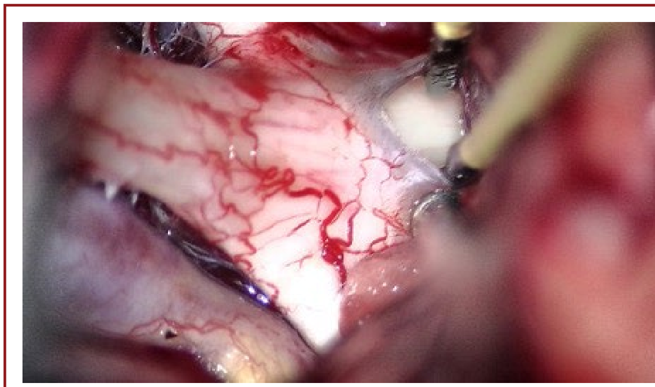

Figure 2. View of the lamina terminal opened during the operation.

flow. Then, Liliequist membrane was opened, and clots were removed from the interpeduncular cistern. In every case, at least 30 min before the closure of all anatomic layers, a 3% papaverine applied Gelfoam® sponge was placed on the clipped aneurysm.

This study was conducted in accordance with the Declaration of Helsinki and ethics committee approval was obtained from the institution where the study was conducted. (B.10.1.TKH.4.34.H.GP.0.01/378 – 23.06.2022).

Statistical Analysis

Student's T-test (parametric), Mann–Whitney Test (non-parametric), Chi-square test, and multivariate analyses were used to compare data. $P<0.05$ was considered statistically significant.

Results

105 patients with aSAH were included in the study. The mean age of the patients was 50.5. Forty-nine of the patients were male, and 56 of them were female. According to first CT imaging of these patients, Fisher scores were given. Thirty-one patients had scored 1, 24 scored 2, 24 scored 4, and 26 scored 4.

17 patients (12 females and 5 males) showed clinical signs of vasospasm. 20 cases (13 females and seven males) of hydrocephalus were detected at the time of admission and were treated with EVD perioperatively.

WFNS scores of these patients according to CT scans at admission were as follows: WFNS 1; 55 patients, WFNS 2; 19 patients, WFNS 3; 7 patients, WFNS 4; 15 patients; and WFNS 5; 9 patients.

Hunt-Hess Gradings were as follows: HH Grade 1; 34 patients, HH Grade 2; 43 patients, HH Grade 3; 10 patients, HH Grade 4; 11 patients; and HH Grade 5; 7 patients.

In 25 of 55 patients with Fisher Scores 1–2, LTF was applied, and shunt-dependent hydrocephalus was observed in two of them in the long term. In 38 of 50 patients with Fisher Scores 3–4, LTF was applied, and shunt-dependent hydrocephalus was observed in sixteen of them. In 4 patients with Fisher Scores 3–4, LTF was not done, and shunt-dependent hydrocephalus was observed. These data are summarized in Table 1.

Discussion

Incidence of shunt-dependent chronic hydrocephalus after aSAH is variable and reported between 6% and 67%[4].

Yaşargil is the first surgeon to apply LTF as a part of neurovascular surgery in anterior circulation aneurysms[11]. Tomasello et al.[13] evaluated LTF's effect on preventing hydrocephalus. In 52 patients included, only 2 of them (4.2%) were reported to develop hydrocephalus in 12- and 60-month follow-ups. In 2002, Komotar et al.[14] reported a decrease in hydrocephalus incidence in more than 80% of patients with a big cohort (582 cases) and underlined the significance LTF. Furthermore, LTF was not only associated with decreased incidence of hydrocephalus but also associated with lesser vasospasm and better clinical outcome[15]. Thus, LTF was advised as a routine procedure in SAH patients[1,11,16–19].

Nevertheless, therapeutic role of LTF has been questioned in the recent studies. Komotar et al.[14] have failed to fine a significant difference between LFT applied and non-LFT applied patients since hydrocephalus rates were 25% and 20%, respectively. Negative results were also reported by other researchers. Cholan et al.[20] applied an intraventricular contrast agent to evaluate the functional patency of LTF. In their report, CSF flow followed the physiologic pathway instead of draining into basal cisterns. To define the controversial role of LTF, a systematic review of 11 studies including 1973 patients was done. In these studies, hydrocephalus incidence in patients with and without LTF was 10% and 14%, respectively, and this difference lacked significance[14]. However, baseline data of two groups were incoherent, and especially in the first group (LFT applied), there were more patients with worse clinical status at admission. High-grade SAH is a risk factor for shunt-dependent hydrocephalus,[8,21] and because of that the question on effectivity of LTF is left unanswered. To answer this question, a well-organized randomized clinical trial was needed.

In the literature review we had done, there was only one RCT done on the topic to answer these controversies[22]. This study including 50 patients, reported no significant difference between LTF applied and non-applied patients (24% against 16%). However, low-grade SAH patients were

Table 1. Analysis of patients included in the study according to Fisher grade and hydrocephalus status

Fisher Score/Patient Count	Patient Count	LTF applied	Shunt-dependent hydrocephalus	LTF non-applied with shunt dependent hydrocephalus
Fisher 1–2	55	25	2	-
Fisher 3–4	60	38	16	4

over 90% and about 60% of patients were Fisher Grade 1–2. Since lower Hunt-Hess grades and Fisher grades have decreased chance of developing hydrocephalus, this cohort was inadequate to detect the efficacy. In addition, this study was clearly limited with a small sample size.

In our study, Fisher Grade 1–2 patients had a lower risk of developing hydrocephalus when compared to Fisher Grade 3–4. When patients with lower Fisher Grades were separately evaluated, LFT applied patients had significantly lower frequency of hydrocephalus. Therefore, as it lowers the hydrocephalus rates, we recommend LTF for patients with lower (Grade 1–2) and higher (Grade 3–4), while emphasizing its efficacy in lower Fisher Grade group.

Limitation of our study is the limited number of cases and its retrospective nature. Because of this, it is important that prospective randomized studies with large cohorts should be planned. Moreover, at the early pre-operative period, patency of LTF and adequacy of CSF flow should be checked with a CSF flow MRI.

Conclusion

The risk of hydrocephalus in LTF-applied patients was lower in Fisher Grade 1–2 patients when compared to Grade 3–4 patients. LTF is an easy and efficacious procedure that allows cerebral relaxation before surgical clipping and decreases the risk of developing hydrocephalus after clipping. LTF decreases the risk of developing hydrocephalus both in low and high Fisher Grade groups, although the decrease in risk is more in lower grade group, we recommend that LTF should be applied to both.

Ethics Committee Approval: This study was conducted in accordance with the Declaration of Helsinki and ethics committee approval was obtained from the institution where the study was conducted. (B.10.1.TKH.4.34.H.GP.0.01/378 – 23.06.2022).

Peer-review: Externally peer-reviewed.

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