

Conclusion: IRRFlow active irrigation and aspiration is a promising new technology in the treatment of intraventricular hemorrhage. With our preliminary data we did not experience any severe adverse events and the implementation has been feasible and safe.

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AUGMENTED REALITY-GUIDED (AR) DRAINAGE OF INTRACEREBRAL HEMORRHAGE: ACCURACY COMPARED TO STEREOTACTIC AND FREEHAND PUNCTURE

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Background: Minimally-invasive intracranial drain placement is a common neurosurgical emergency procedure in patients with intracerebral hemorrhage (ICH). We aimed to retrospectively investigate the accuracy of conventional (bedside) hemorrhage drain placement and to prospectively compare the accuracy of augmented/mixed reality-guided (AR) versus stereotactic-guided (STX) and conventional drain placement in a phantom model.

Methods: A retrospective, single-center analysis evaluated the accuracy of drain placement in 73 consecutive ICH with a visual rating of postinterventional computed tomography data. In a head phantom with a simulated deep ICH, five neurosurgeons performed four punctures for each technique: STX, AR and the conventional freehand technique in randomized sequence (60 operations). The Euclidean distance to the target point and the lateral deviation of the achieved trajectory from the planned trajectory at target point level were compared between the three methods.

Results: Analysis of the clinical cases revealed an optimal drainage position in only 46/73 (63%). Correction of the drain was necessary in 23/73 cases (32%). In the phantom study, accuracy of AR was significantly higher than the conventional method ($p < 0.001$ for both Euclidean and lateral distances). The Euclidean distance using AR (median 3 mm) was close to that using STX (median 1.95 mm; $p = 0.023$).

Conclusion: We demonstrated that the accuracy of the conventional technique was low and that subsequent position correction was common. In a phantom model, AR drainage placement was significantly more precise than the conventional method. AR has great potential to increase precision of emergency intracranial punctures in a bedside setting.

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BASILINE PERIHAEMATOMAL OEDEMA AND CRP ARE NOT ASSOCIATED WITH 30-DAY MORTALITY IN INTRACEREBRAL HAEMORRHAGE

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Background: The relationship between baseline perihematoma edema (PHE) and inflammation, and their impact on mortality after intracerebral hemorrhage (ICH) are not well understood. We aimed to assess the association between PHE, C-reactive protein (CRP) at baseline and early death after ICH.

Methods: Analysis of pooled data from multicenter ICH registries. We included patients presenting within 24 hours of symptom onset. We used a multifactorial linear regression model to assess the association between CRP and edema extension distance (EED), and a multifactorial Cox regression model to assess the association between CRP, PHE volume and 30-day mortality.

Results: We included 1034 patients. Median age was 69 (interquartile range [IQR] 59-79), median baseline ICH volume was 11.5 (IQR 4.3-28.9) mL, and median baseline CRP 2.5 (IQR 1.5-7.0) mg/L. In the multivariable analysis (adjusting for age, sex, log-ICH volume, ICH location, intraventricular hemorrhage (IVH), statin use, glucose, systolic blood pressure and cohort) there was some evidence of association between baseline log-CRP with baseline EED (for a 50% increase in baseline CRP the difference in expected mean baseline EED was 0.002 (95%CI < 0.001 to 0.003, $p = 0.055$). Neither log-CRP nor log-PHE volume were associated with 30-day mortality (after adjusting for age, baseline Glasgow Coma Scale score, log-ICH volume, ICH location, statin use, IVH, baseline glucose and cohort): a 50% increase in baseline CRP was associated with a 0.9% decrease in the hazard of death (95% CI 3.2% to 1.4%, $p = 0.411$) and a 50% increase in baseline PHE was associated with a 0.5% decrease in the hazard of death (95% CI -1.9% to 2.2%, $p = 0.511$).

Conclusion: Higher baseline CRP might be associated with higher baseline edema but not mortality. Edema at baseline (vs. later time points) might be driven by different pathophysiological processes with different effects on outcome which requires further investigation.

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INITIAL SINGLE-CENTER EXPERIENCE WITH MIDDLE MENINGEAL ARTERY EMBOLIZATION FOR TREATMENT OF CHRONIC SUBDURAL HEMATOMA

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Background: Chronic subdural hematoma (cSDH) is a common disease among elderly characterized by an organized collection of mostly liquefied blood beneath the dura. The traditional treatment of cSDH is surgical evacuation of symptomatic or space-occupying hematoma. Recurrent hemorrhages requiring repeated operations are common affecting 10–20% of patients. Middle meningeal artery (MMA) embolization has recently emerged as a promising minimally invasive treatment as an alternative or adjunctive to surgery for cSDH. In this study, the authors describe the single-center initial clinical and radiographic outcomes after 52 cases of MMA embolization for cSDH among 40 elderly patients.

Methods: We introduced this method in April 2020 in our clinic and have so far performed 52 MMA embolizations for 40 predominantly male (85%) patients with mean age of 78 years (53 – 94). Primary clinical and radiographic details were collected retrospectively at follow up 6 weeks, 3 and 6 months post-procedure. Significant thickness reduction on follow-up CT, defined as $> 50\%$ compared to pretreatment, was evaluated. Additional surgical treatment needed after MMA embolization was defined as failure of therapy.

Results: All procedures were performed under general anesthesia and 98% of them were completed successfully. The majority of patients (69,2%) were treated additional to previous surgery, 23% have had multiple surgeries for cSDH. 34,6% of embolizations were done via femoral and 65,4% via radial access. Particle embolization were used in 88,5% and liquid embolic materials in 11,5% of the procedures. On last follow up (mean 149 days after embolization) significant reduction of cSDH thickness was achieved at 88,4% of patients, only 2 patients required additional surgery for cSDH. Two minor complications (AV-fistulas and branch retinal artery ischemia) without clinical relevance were noticed.

Conclusion: MMA Embolization as a stand-alone or adjunctive treatment for surgical candidates is a promising new frontier for endovascular neuro-interventions with good efficacy and safety profile. Several ongoing randomized clinical trials might soon provide high-level evidence for this novel intervention.

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MANAGEMENT OF SPONTANEOUS SUBARACHNOID HEMORRHAGE: RESULTS OF A NATIONAL SURVEY IN GERMANY

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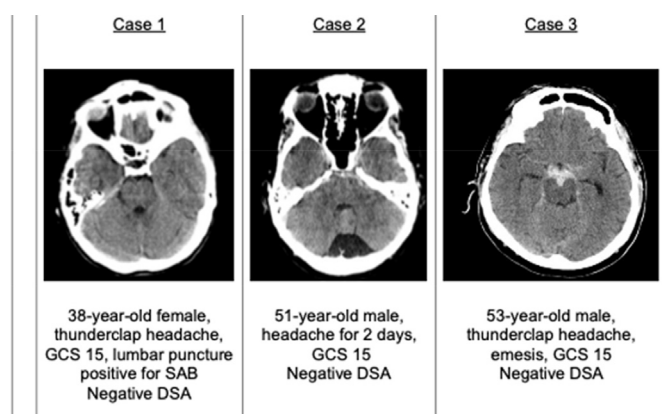
Background: Spontaneous subarachnoid hemorrhage (sSAH) accounts for approximately 15% of all patients with SAH. However, management guidelines are not established, therefore we conducted a Germany-wide survey to evaluate

the treatment regimens performed.

Methods: This prospective national survey analyzes the management of patients suffering from sSAH. The survey encompasses three different cases evaluating the treatment and follow-up regime.

Results: 55 questionnaires (31%) were fully answered. Most centers (69.1%) treat 10-20 sSAH patients per year. With a complication rate of up to 10% reported by 92.7% of the centers. Patients are mostly treated in the intensive/intermediate care unit (case 1: 94.5%; case 2: 96.4%; case 3: 100%). In case 1 54.5% (case 2: 60.0%; case 3: 74.5%) would perform invasive blood pressure monitoring (BPM), whereas non-invasive BPM is recommended in 41.8% (case 2: 38.2%, case 3: 23.6%). However, 3.6% (case 2: 1.8%, case 3: 1.8%) would not perform any BPM. Vasospasm prophylaxis including repetitive transcranial dopplersonography (TCD) is recommended in case 1 in 40% (case 2: 38.2%; case 3: 61.8%), however a lot of centers also perform TCD monitoring without vasospasm prophylaxis (case 1: 32.7%; case 2: 36.4%; case 3: 21.8%). Although all cases present with a negative digital subtraction angiography (DSA), follow-up DSA is advocated in most centers (case 1: 70.9%; case 2: 72.7%; case 3: 87.3%) most often within the first 3 weeks (case 1: 49.1%, case 2: 47.3%, case 3: 65.6%).

Conclusion: This study confirms that even in case of missing guidelines sSAH patients are often treated similar.



BRAIN AND SPINE 2 (2022) 101190 101439 ACTIVE REMOVAL OF CEREBRAL HAEMORRHAGE VIA CSF EXCHANGE

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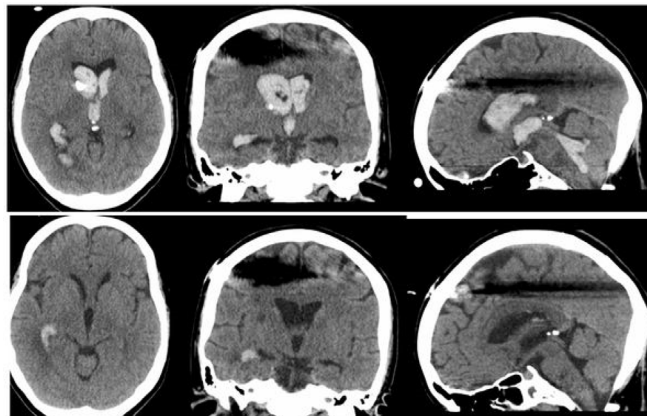
Background: Intracerebral hemorrhage (ICH) associated with intraventricular hematoma (IVH) has higher rates of morbidity and mortality. Removal of IVH depends on passive external ventricular drainage, which is time consuming and gives opportunity to IVH re-organise and have neurotoxicological effect. Quick removal of ICH and IVH should result in less organisation of blood in the cerebrospinal fluid (CSF) thus minimising neural toxicity, enhance neurologic outcomes and reduce ICU time.

Methods: We tested a novel fluid exchange system (active EVD) with controlled tPA infusion on 7 ICH and IVH cases to determine if rapid removal of blood could occur. In 2 cases, 2mg of tPA was administered manually over 2 consecutive days. In the other 5 cases, 2mg of tPA in 1,000 cc's of fluid was continuously infused over a period of 1-4 days.

Results: In all 7 cases, CT demonstrated 90% removal of blood occurring in 72 hours or less. Further, in all cases, complete treatment with the active EVD device, was completed in an average of 5 days. Figure 1 demonstrates removal of IVH in 47h with 2,4mg tPa.

Conclusion: Active removal of IVH with infusion of tPA with active EVD

significantly increases the removal of blood and reduces treatment times compared to standard EVD treatment. Further, our case series substantiated a significant reduction in ICH. For this reason, we need future studies to assess the impact of tPA administration in ICH with active fluid exchange on neurological outcomes, ICU treatment time and need of standard EVD treatment.



2 SPINAL NEUROSURGERY

2.1 Degenerative Diseases

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CLINICAL AND RADIOLOGICAL OUTCOMES OF OBLIQUE LATERAL LUMBAR INTERBODY FUSION

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Introduction: Oblique lateral lumbar interbody fusion (OLLIF) is a recent innovation in MI spinal fusion. OLLIF is performed with the patient in the prone position and employs an oblique lateral approach that enables the instrumentation to pass through Kambin's triangle.

Material and Methods: This study is a retrospective case series including 303 OLLIF procedures performed by the same surgeon. Procedures were performed in five Minnesota hospitals.

All patients underwent a full course of conservative therapy before being considered candidates for surgery. Preoperative imaging included magnetic resonance imaging, X-ray of the lumbar spine with flexion and extension. OLLIF is indicated for severe degenerative disc disease, spondylolisthesis, spinal stenosis and disc herniation.

Results: Perioperative outcomes are stratified by the number of surgical levels. For a single-level OLLIF, mean surgery time was 52 ± 18.9 minutes, with a blood loss of 42.2 ± 31.1 mL, 198.8 ± 87.2 seconds of fluoroscopy time and a hospital stay of 2.2 ± 1.7 days. Linear regression shows that controlling for the number of levels, there is no significant impact of BMI on surgery time (OLS coefficient 0.23, 95% CI -0.15 to 0.61) and that each additional level of surgery increases surgery time by 24.9 (95% CI 21.72 to 28.10) minutes.

Conclusion: This study is the first to present outcomes in a large cohort of OLLIF patients. We demonstrate that OLLIF is a safe, efficient and efficacious technique for fusions of the lumbar spine from T12-L1 to L5-S1. In OLLIF, the spine is approached without compromising supportive connective tissue, muscles or osseous structures. This allows for faster surgeries and short hospitalization even in patients with significant disability and obesity. Based on our perioperative, clinical, and radiographic data we propose that OLLIF should be considered a preferred option for fusions of the lumbar spine.

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PERIOPERATIVE OUTCOMES OF MINIMALLY INVASIVE SACROILLIAC JOINT FUSION USING HOLLOW SCREWS THROUGH A LATERAL APPROACH: A SINGLE SURGEON RETROSPECTIVE COHORT STUDY

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Traditionally, SIJ fusion was performed using an open technique that required