Net Drainage as a Novel Metric for Irrigating Drainage Systems in Chronic Subdural Hematoma Management: A Case Report

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BACKGROUND AND IMPORTANCE: Chronic subdural hematoma (cSDH) is a common neurosurgical pathology with a projected increase in prevalence as the elderly population grows. Traditional treatment for cSDH involves burr hole drainage or craniotomy with or without a subdural drain. This case describes a novel irrigation and drainage protocol using IRRAflow dual-lumen catheter system that utilizes early irrigation and measurement of the net fluid output to improve postoperative outcomes.

CLINICAL PRESENTATION: A 75-yr-old male presented to the emergency department with 2 wk of progressive dizziness, headache, confusion, and left-sided weakness over the past week. Computed tomography (CT) of the head showed 25-mm-thick, right-sided cSDH with 7 mm of right-to-left midline shift. The patient was taken to the operating room for right-sided craniotomy for subdural hematoma evacuation with placement of IRRAflow irrigating drain in the subdural space. The IRRAflow drain irrigated at 100 cc/h for 23 h with net output consistently greater than irrigation rate. Head CT the following day showed a progressive decrease in subdural collection. The patient was discharged on postoperative day 2 and had complete resolution of his neurological symptoms by postoperative day 11.

CONCLUSION: As cSDHs become more prevalent in the aging population, development of improved management strategies is imperative. This report describes the use of an IRRAflow dual-lumen catheter with a novel protocol consisting of a high rate of irrigation but net fluid output, which led to rapid recovery and resolution of neurological deficits in a patient with a cSDH.

KEY WORDS: Case report, Chronic subdural hematoma, Continuous irrigation, Irrigating drainage system, IRRAflow, Drainage, Net fluid output, Hospital stay

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Chronic subdural hematoma (cSDH) is a common pathology that affects 1.72 to 20.6 per 100 000 persons per year.[1] This pathology disproportionately affects the elderly population because of use of anticoagulants, decreased brain volume, and increased fall risk.[2] The prevalence of cSDH is projected to increase as the average population age rises.[3,4] Approaches to treating cSDH include burr hole drainage or craniotomy with or without use of a surgical drain.[5] Hematoma recurrence is a common complication, occurring in 8.33% to 12% of cases.[6] Although subgaleal, subperiosteal, and subdural drainage each have been shown to reduce recurrence rates following burr hole evacuation,[2,6-10] a recent prospective randomized controlled trial found increased rate of cerebral parenchymal injury with subdural drainage compared to subgaleal.[11] Irrigation through the subdural drain is an adjunctive strategy for cSDH with similar results as simple drainage.[10,12,13] In a large multicenter retrospective trial, continuous irrigation was associated with a low recurrence rate but a higher complication rate compared to drainage alone.[10]

The IRRAflow drain (IRRAS, Stockholm, Sweden) is a dual-lumen catheter recently FDA approved in the United States that simultaneously irrigates and drains fluid from the

ABBREVIATIONS: cSDH, chronic subdural hematoma; **POD,** postoperative day

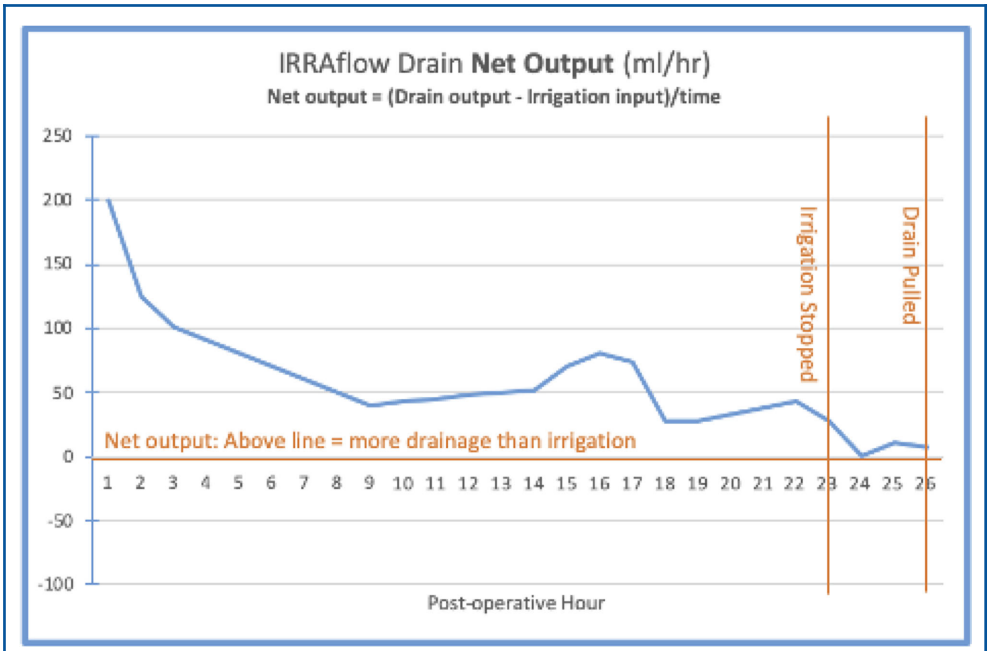

FIGURE 1. *Net output from the IRRAflow continuous irrigation and drainage system over time during the first postoperative day.*

intracranial space and monitors intracranial pressure (ICP) and net fluid output. A previous case at this institution demonstrated the first use of the IRRAflow irrigating drainage system for postoperative cSDH management after craniotomy in the United States.[14] The present case describes a novel drainage protocol, which utilizes early aggressive irrigation and measurement of net fluid output to improve postoperative outcomes and decrease length of stay.

CLINICAL PRESENTATION

A 75-yr-old male presented to the emergency department with 2 wk of progressive dizziness, headache, confusion, and left-sided weakness. Physical examination was notable for left pronator drift and mild weakness of the left upper extremity. Sensation to fine touch, pinprick, and cranial nerves II through XII were intact bilaterally. Computed tomography (CT) of the head showed 25-mm-thick, right-sided cSDH with 7 mm of right-to-left midline shift.

The patient consented for surgery and involvement in research prior to surgery (institutional review board ethics approval deferred, as University of California, Irvine policy permits reports of up to 3 individuals). He was taken to the operating room for craniotomy with placement of IRRAflow irrigating drain in the subdural space. A burr hole was created, and the dura was coagulated and opened in a cruciate fashion, revealing dark serosanguineous fluid. This was expelled with copious irrigation until the fluid returned clear. This was repeated for the inner dural membrane. An IRRAflow drain was tunneled into the subdural space and left in a dependent location, and the dura was reapproximated loosely prior to closure.

The IRRAflow drain irrigated at 100 cc/h for 23 h with net output decreasing over time. Average net output was 43.6 cc/h (net output = [drain output/time] – [irrigation rate/time]). Drain output was consistently greater than irrigation (Figure 1). Repeat head CT on postoperative day (POD) 1 showed the subdural collection decreased to 12 mm with trace midline shift (Figure 2). Irrigation was discontinued and the catheter continued to drain for 3 h. Net output decreased to 3 cc/h and was removed later on POD1. The patient's neurological exam returned to baseline, and he was discharged on POD2 to an acute rehabilitation unit, where he continued to improve until discharge on POD10. The patient followed up with neurosurgery on POD11 with complete resolution of his preoperative weakness.

DISCUSSION

Although cSDH is expected to be the most common cranial neurosurgical condition in the United States by 2030,[4,15] there is little consensus among neurosurgeons on optimal surgical technique or postoperative management protocol.[3,16] Irrigation has been used more frequently, likely because of low hematoma recurrence rates (0.36%-33.3%).[17] The pathogenesis of cSDH recurrence may be related to presence of vasoactive cytokines, inflammatory mediators, fibrinolytic factors, and other mediators in the hematoma cavity.[18] Continuous irrigation washes out these

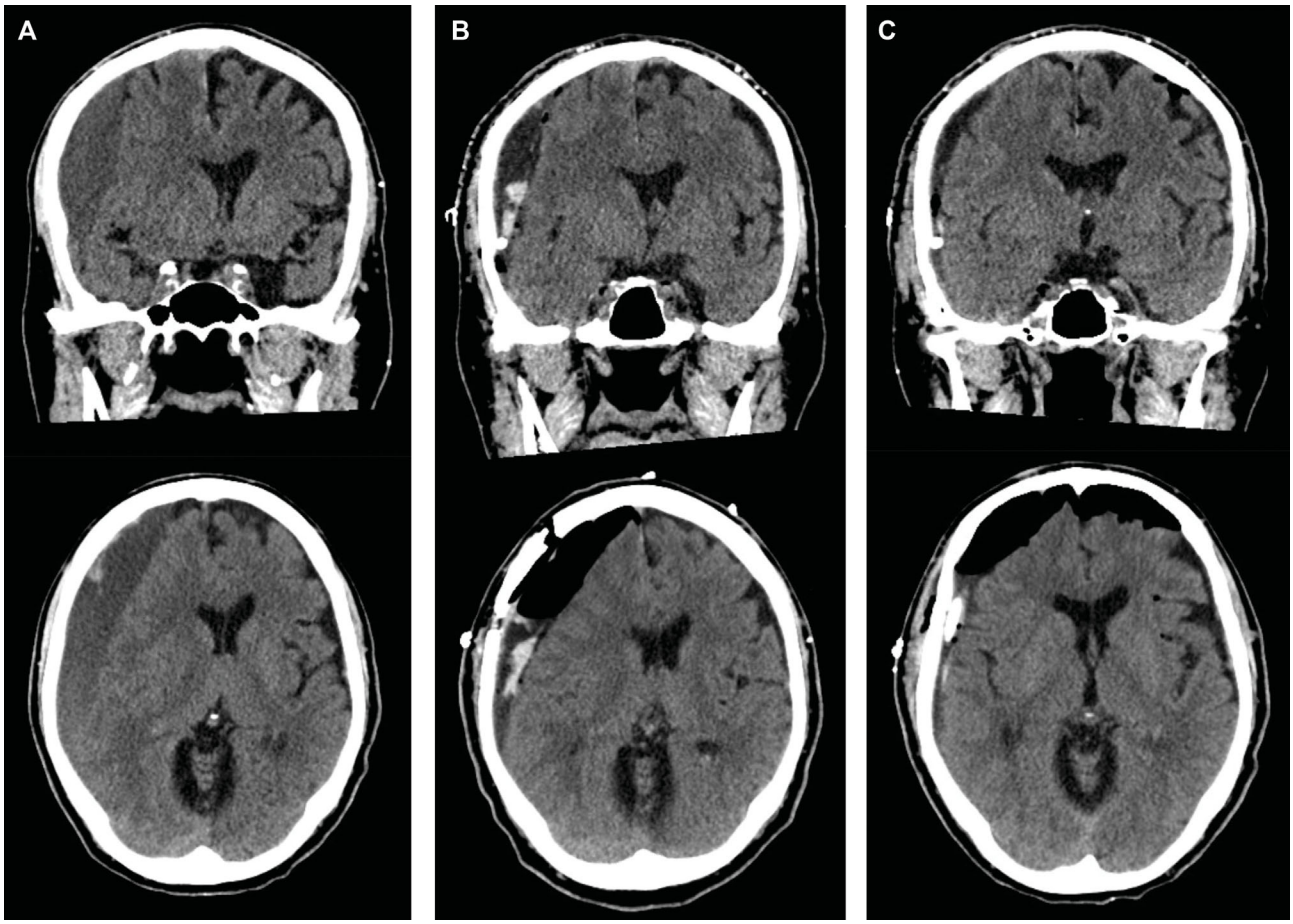

FIGURE 2. *Axial and coronal head computed tomography.* **A**, *Preoperative imaging shows 25-mm-thick, mixed attenuating, extra-axial hemorrhage, causing 7 mm leftward midline shift.* **B**, *Immediate postoperative imaging shows pneumocephalus and mixed attenuating, extra-axial collection with persistent 7 mm leftward midline shift.* **C**, *Postoperative day 1 imaging shows decrease in extra-axial collection to 12 mm thick with trace midline shift.*

factors and prevents residual blood products from coagulating, which may reduce hematoma recurrence.

One obvious concern with irrigating fluid into the intracranial vault is the risk of increasing the intracranial pressure because of the Monroe-Kellie hypothesis. This states that an equilibrium exists between brain tissue, blood, and cerebrospinal fluid and that any shift in one of these components necessarily results in a decrease in the others.[19] The IRRAflow has a constant ICP monitor built in, and limits are set manually to alarm the nurse and automatically stop irrigation when ICP rises above the upper limit, which prevents a deleterious rise in ICP.

In the current report, we stopped irrigation based on 2 parameters: when the color and volume of output fluid became the same as input fluid. This indicated that we were no longer clearing any further collection. We switch the IRRAflow to "drain only" mode for a few hours to allow any additional collection to drain. Moving forward, we will be more aggressive with initial irrigation parameters (90-100 cc/h) and modulate our irrigation based on color and amount of drainage.

Currently, patients remain in the intensive care unit while the drain is in because the drain is monitored hourly, and step-down nurses are not educated on using the IRRAflow. However, with broader implementation and education, patients may be managed in step down in the future. Antibiotic-impregnated irrigation solution may be considered for management of external ventricular drain-associated infections, which range from 0% to 22%.[20] However, we have observed neither catheter-related infections nor used antibiotics as prophylaxis at this time.

Early aggressive irrigation resulted in excellent resolution of the subdural hematoma without recurrence or complication. The patient was discharged on postoperative day 2, which is earlier than the average length of 6 d reported by Soleman et al.[6] Although more work is required to strengthen the evidence supporting this irrigation and drainage protocol, this

report provides a novel metric that can be used to guide future investigation when performing subdural hematoma drainage with an irrigating catheter.

CONCLUSION

cSDH is an increasingly prevalent neurosurgical pathology. This report describes a patient with cSDH that was evacuated and irrigated using a dual-lumen catheter with a novel irrigation protocol using a high rate of irrigation and net fluid output. The patient recovered rapidly and improved consistently, with complete resolution of his neurological defects within 2 wk.

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Disclosures

Dr Vadera is a consultant for IRRAS. The other authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this article.

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COMMENTS

Chronic subdural hematoma (cSDH) is a common pathology with an incidence around 1.7 per 100 000 people per year. Unfortunately, recurrence is common, estimated as high as 33% in some series.[1] Recurrence can lead to additional morbidity, increased length of stay, and an increase in hospital costs. In order to address this problem with the treatment of cSDH, many different devices and techniques have been developed to prevent recurrence.

One new technique is middle meningeal artery embolization, which attempts to address the underlying pathology of cSDH by preventing the formation of fragile capillaries within the dural border cell layer which can rupture and lead to continued hemorrhage.[2] Though the effectiveness of this treatment is still being investigated in randomized clinical trials, preliminary findings are promising with recurrence rates being reported to be between 2.1% and 3.6%.[3]

Self-irrigating catheter systems such as the Irraflow system (IRRAS) have recently been trialed in the treatment of cSDH. One case series reported a decrease in average length of stay from 6 to 2.83 d.[4] The authors of this manuscript did a thorough job describing the operative details of this technique which hopefully will foster further research of this pathology.

Though many of novel treatment modalities are still in their infancy, they are rapidly becoming an important part of daily practice as a neurosurgeon. Continuing to understand and embrace new technology such as self-irrigating drainage systems is now of the utmost importance. We commend the authors of this paper for their contribution to this important endeavor.

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Innovation is welcome in neurotrauma. An aging population and prevalent use of anticoagulants are making chronic subdural hematoma an increasingly frequent pathology for neurosurgeons to manage. This case report describes he use of a new irrigation technology for this condition. I found this an interesting idea as my personal habit in the surgical management of this condition has been to thoroughly irrigate through the subdural drain at the time of its placement - until the effluence is clear. I look forward to future publications reporting on the efficacy of this technology in larger groups of patients. Readers should note that the senior author of this manuscript serves as a consultant for the manufacturer of this device.

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