Local anesthesia with sedation and general anesthesia for the treatment of chronic subdural hematoma: a systematic review and meta-analysis

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Abstract. – OBJECTIVE: Drilling and drainage is the main treatment for chronic subdural hematoma (cSDH). However, anesthesia methods also have an important effect on patients' postoperative outcomes. The clinical effect of drainage of cSDH under local anesthesia with sedation (LAS) and general anesthesia (GA) was systematically evaluated.

MATERIALS AND METHODS: A literature study was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for studies that compare LAS and GA for cSDH. The following treatment outcomes were compared between LAS and GA: total duration of surgery, postoperative complications, mortality, recurrence rate, and hospital length of stay (LOS).

RESULTS: Four papers (n = 391, LAS: 196, GA: 195) met the inclusion criteria. Although there was no statistically significant difference between the two groups in mortality (OR: 0.47, 95% CI: 0.06–3.84, $p = 0.48$; $p = 0.2$, $I^2 = 39\%$), recurrence rate (OR: 0.82, 95% CI: 0.33–2.04, $p = 0.66$; $p = 0.69$, $I^2 = 0\%$), LOS (ratio of means: 0.86, 95% CI: 0.71–1.05, $p = 0.14$; $p = 0.02$, $I^2 = 75\%$). The total duration of surgery (MD: –26.71 min, 95% CI: –37.29 to –16.13, $p < 0.00001$; $p = 0.65$, $I^2 = 0\%$) was significantly shorter and the number of postoperative complications was significantly lower in the LAS group compared with the GA group (OR: 0.25, 95% CI: 0.13–0.50, $p < 0.0001$; $p = 0.62$, $I^2 = 0\%$).

CONCLUSIONS: A systematic review and meta-analysis of the existing literature showed that LAS reduces the total duration of surgery and postoperative complications compared to GA. No significant difference in mortality, recurrence rate, and LOS was observed between the two groups.

Key Words:
Local anesthesia, General anesthesia, Sedation, Chronic subdural hematoma.

Introduction

Chronic subdural hematoma (cSDH) is a common neurosurgical disease that often occurs in elderly patients[1]. cSDH is considered to involve progressive and recurrent bleeding resulting in rupture of the bridging vein[2]. Although atorvastatin has been used in the conservative treatment of cSDH in recent years, surgery remains the first choice for the treatment of cSDH, particularly due to the placeholder effect[3]. The most common surgical treatment for cSDH is drilling drainage[4]. The main types of anesthesia used for drilling drainage include local anesthesia (LA) and general anesthesia (GA)[5]. In the case of LA, a small area is anesthetized for a short time. For patients with LA, poor medical experience, agitation, and lack of cooperation during surgery increase the risk of complications during surgery. GA has a longer duration. GA allows patients to undergo surgery in an unconscious state, reducing patients' fear and improving the therapeutic effect. However, GA may increase the risk of intraoperative and postoperative complications, such as hemodynamic instability, pulmonary infection, and thrombosis, and increase hospitalization costs. When treating cSDH patients with drilling drainage, it is important to choose the appropriate anes-

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thesia. GA is more controllable intraoperatively than LA, and GA is preferred by many surgeons and anesthesiologists. Some studies[6,7] have proposed that LA with sedation (LAS) for external drainage of cSDH can reduce the risk of intraoperative activity while avoiding postoperative complications associated with GA. This study evaluated the clinical effectiveness of LAS *vs.* GA for drainage of cSDH using meta-analysis, aiming to provide medical evidence for drainage of cSDH under different anesthetic modalities.

Materials and Methods

The analysis and generation of inclusion criteria were based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines[8] (**Supplementary Figure 1**).

Literature Search and Exclusion Criteria

Randomized clinical trials (RCTs) were selected from the Medline and Cochrane Control Center registers. We systematically searched electronic databases up to January 2022, including PubMed/Medline, Embase, and Cochrane by using Boolean operators "OR" and "AND," in combination or, alone with the following keywords: "chronic subdural hematoma," "subdural hematoma," "subdural hemorrhage," "subdural bleeding," "local anesthesia," "general anesthesia," "anesthesia," and "sedation." In the first stage of screening, titles and abstracts were screened for relevant studies. Subsequently, the full texts were downloaded and assessed for eligibility. This process was carried out independently by three researchers (HYL, LLY, and XYD). Any disagreements were settled by consensus.

RCTs were selected from the Medline and Cochrane Control Center registers. Non-randomized controlled (retrospective and prospective) trials and pre- and postintervention studies, observational and cohort studies, and post-hoc analyses of observed data from trials were included if a control group was reported. Studies including only LA or GA, animal studies, studies lacking important indicators, case reports, and reports in languages other than English were excluded.

Article Evaluation and Data Extraction

The Jadad scale was used for quality evaluation of RCTs, and the Newcastle-Ottawa Scale (NOS) was used for quality evaluation of retrospective and cohort studies.

The extracted data included the first author, year of publication, number of cases, patient sex, patient age, total duration of surgery, postoperative complications, mortality, recurrence rate, and LOS.

Statistical Analysis

Analysis was performed using RavMan 5.3 software. The meta-analysis results of binary outcomes are expressed as OR and 95% CI, and continuous variables are expressed as weighted mean difference (MD) and 95% CI. Statistical heterogeneity among the studies was analyzed using the I^2 test, where $I^2 > 50\%$ indicates heterogeneity and $I^2 > 75\%$ indicates strong heterogeneity. $p < 0.05$ was considered to indicate statistical significance.

Heterogeneity between variable groups due to the inclusion of non-randomized studies was analyzed by using the general inverse variance method based on data adjusted for potential confounders.

Ethics

This study is a systematic review and meta-analysis that does not involve human participation. Informed consent and ethical approval were not required.

Results

Literature Search

We retrieved 269 records by searching the databases, and after removing duplicate results, a total of 252 records were available for checking the title and abstract. In total, 16 full-text articles were evaluated. A study from which relevant data could not be extracted was excluded[5]. Four studies[9-12] met the inclusion criteria and were included in the present analysis.

Characteristics of Included Studies

Three studies[9-11] were prospective, and one was a retrospective cohort study. The largest study[9] included 257 patients (130 LAS, 127 GA), while the smallest study[10] included 30 patients (15 LAS, 15 GA).

Analysis of Data

Two studies[11,12] reported the total duration of surgery (51 LAS cases and 53 GA cases). The total duration of surgery of the LAS group was

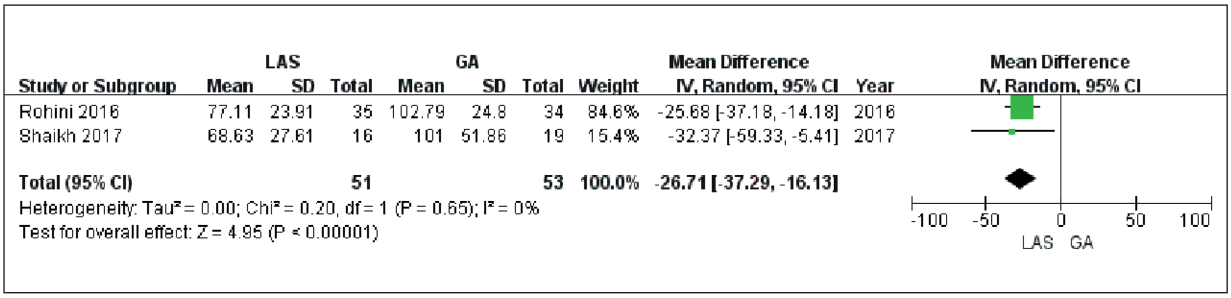

Figure 1. Forest plot analyzing the effects of LAS and GA on the total duration of surgery.

significantly shorter than that of the GA group (MD: −26.71 min, 95% CI: −37.29 to −16.13, $p < 0.00001$; $p = 0.65$, $I^2 = 0\%$) (Figure 1).

Four studies[9-12] reported postoperative complications (12 out of 196 LAS cases and 42 out of 195 GA cases). Postoperative complications in the LAS group mainly included epileptic seizure and incision infection. Postoperative complications in the GA group mainly included pulmonary infection, pleural effusion, coma, epileptic seizure, and cognitive or motor function deterioration. Pooled analysis revealed a statistical difference in postoperative complications between the LAS group and the GA group (OR: 0.25, 95% CI: 0.13-0.50, $p < 0.0001$; $p = 0.62$, $I^2 = 0\%$) (Figure 2).

Three studies[9-11] reported the postoperative recurrence of cSDH (9 out of 161 LAS cases and 11 out of 161 GA cases). No statistical difference in the recurrence of cSDH was observed between the LAS group and the GA group (OR: 0.82, 95% CI: 0.33-2.04, $p = 0.66$; $p = 0.69$, $I^2 = 0\%$) (Figure 3).

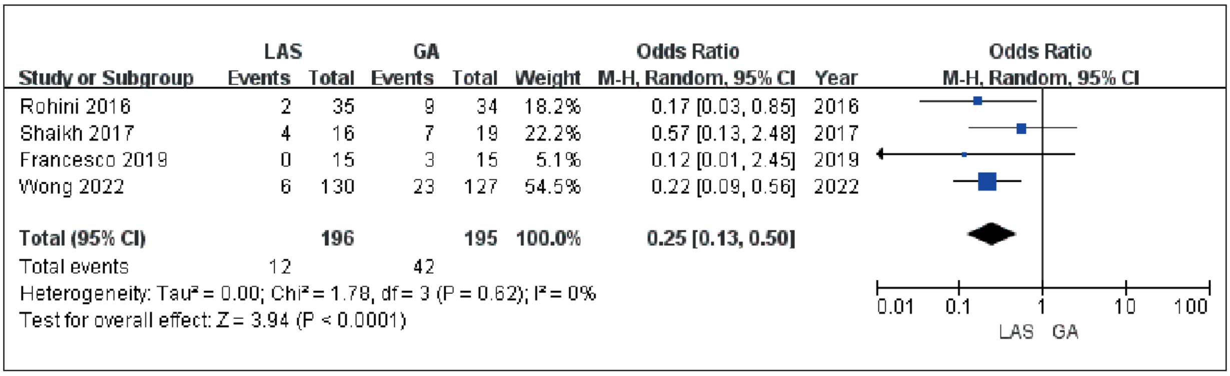

Figure 2. Forest plot analyzing the postoperative complications after LAS and GA.

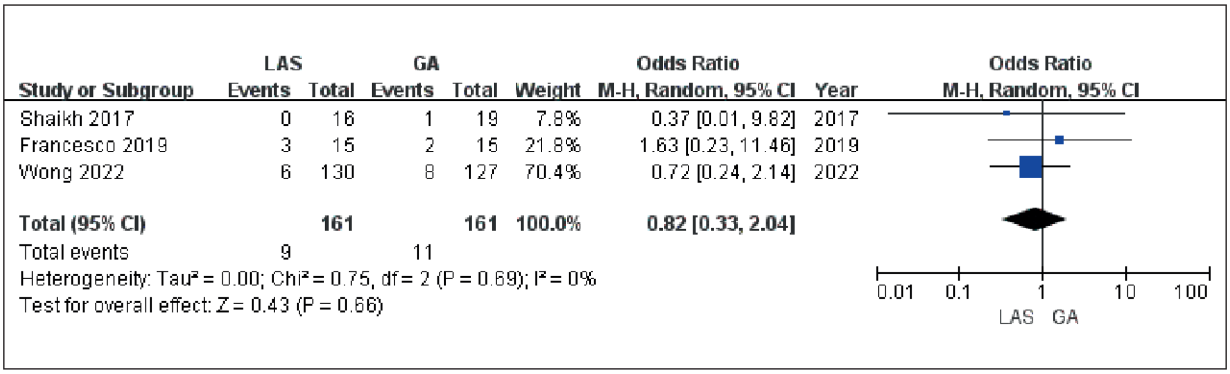

Figure 3. Forest plot analyzing the postoperative recurrence after LAS and GA.

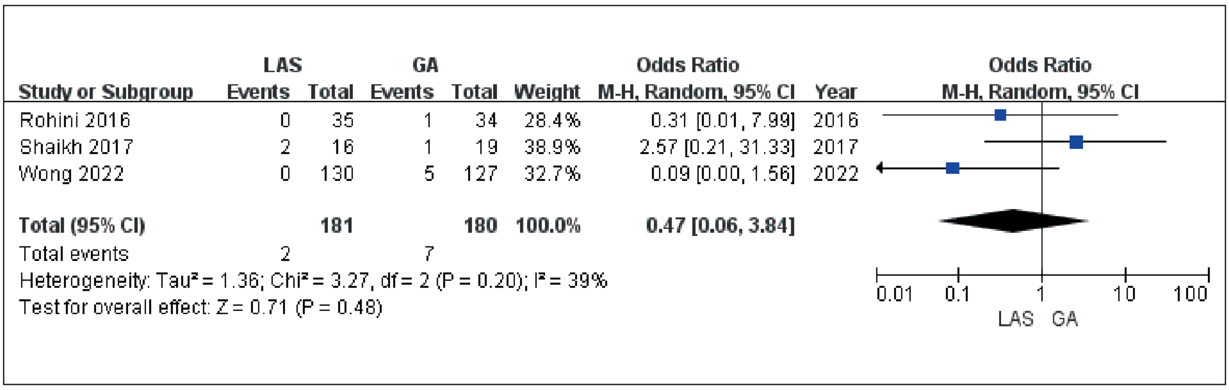

Figure 4. Forest plot demonstrating the postoperative mortality after LAS and GA.

Three studies[9,11,12] reported mortality data (2 out of 181 LAS cases and 7 out of 180 GA cases). No statistical difference in mortality was observed between the LAS group and the GA group (OR: 0.47, 95% CI: 0.06-3.84, $p = 0.48$; $p = 0.2$, $I^2 = 39\%$) (Figure 4).

Four studies[9-12] reported LOS, one study[11] was excluded because of inconsistencies result, only three studies[9,10,12] were included in our analysis. We calculated the ratio of mean LOS for the GA and LAS groups[13]. For example, if the mean LOS was 4.5 days in the GA group and 5 days in the LAS group, ratio of means = 4.5/5 = 0.9. We calculated the log (ratio of means) and standard error (SE) (log(ratio of means))=SE using the Taylor series method. No statistically significant difference in LOS was observed between the LAS and GA groups (ratio of means: 0.86, 95% CI: 0.71–1.05, $p = 0.14$; $p = 0.02$, $I^2 = 75\%$) (Figure 5).

Risk of Bias

Most of the studies had an overall moderate risk of bias, as assessed by the NOS, with a mean of 5.75 stars and a standard deviation (SD) of 0.96 star.

Discussion

Guénot's study[14] show that cSDH is first described 1656. It is a common lesion that is easy to treat and has low morbidity and mortality rates. The incidence of cSDH is estimated at 8.2 per 100,000 persons per year, with an average age of onset of 63 years, and the prevalence thereof is expected to increase with age[15]. cSDH is considered a hematoma cavity surrounded by outer and inner membranes, where the outer membrane contains many fragile vessels that are often the source of recurrent multifocal bleeding[16]. Overactivation of the coagulation and fibrinolysis system and high expression of tissue-type fibrinogen activator in the hematoma have been proposed as possible reasons for the inability to clot[17]. The risk factors of cSDH include head trauma, diabetes, antiplatelet drugs, liver insufficiency, and hemodialysis[3,18,19]. The most common clinical manifestation of cSDH is headache, and diagnosis often requires the patient's clinical manifestations, computed tomography (CT), and magnetic resonance imaging (MRI). CT remains the pre-

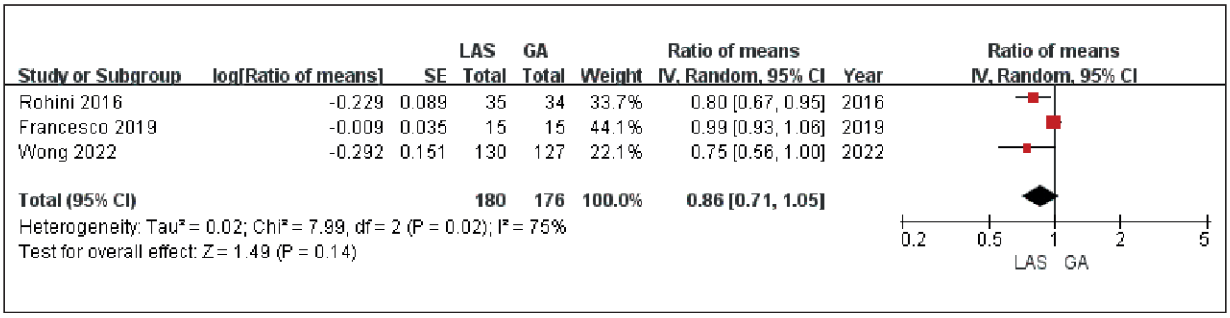

Figure 5. Forest plot demonstrating the LOS after LAS and GA.

ferred diagnostic procedure for cSDH scanning, and MRI helps distinguish the stages of a subdural hematoma. After decades of research, drug conservative treatment is feasible for patients with mild occupying effects and mild clinical symptoms, while surgical treatment is the first choice for patients with significant occupancy effects in the clinic[3]. Surgery by twist drill craniotomy (TDC) or burr hole drainage (BHC) is the main treatment method worldwide. The types of anesthesia include LA and GA. The optimal type of anesthesia to use in cSDH remains controversial. GA is preferred by many surgeons and anesthesiologists.

cSDH occurs mostly in the elderly, with poor basic conditions. Heart disease, pulmonary diseases, and other complex conditions increase the risk of cSDH. Recent studies[9,12,20,21] have proposed that LAS with drugs such as midazolam, fentanyl, and dexmedetomidine can shorten the duration of surgery, reduce the LOS, and even reduce the mortality rate. However, there is a lack of evidence to confirm this. We conducted a systematic review and meta-analysis focusing on the total duration of surgery, postoperative complications, mortality, recurrence rate, and LOS.

When the duration of surgery is reduced, the risk of thromboembolism, hypothermia, and intraoperative adverse events is reduced as well. These risks are lower in the case of LAS because GA requires induction of anesthesia, intubation, and extubation. Our analysis also supports the notion that LAS significantly reduced surgical time compared to GA. Two studies[11,12] reported that the total duration of surgery with LAS was 77.11 ± 23.91 and 68.63 ± 27.61 minutes and that with GA was 102.79 ± 24.80 and 101 ± 51.86 minutes. Combined analysis shows that this difference is statistically significant ($p < 0.00001$).

Numerous reports[22,23] show that LA and GA are associated with different complications. Respiratory depression may occur when surgery is performed under sedation. The intraoperative complications of LAS may include insufficient sedation dose, hypotension, infusion reaction, and rash[12]. These complications may also occur in the case of GA. After both LAS and GA, patients are bedridden for several days due to the need for a drainage device for subdural drainage, which can lead to complications such as lung infection, urinary tract infection, deep vein thrombosis (DVT), and bedsores, especially in the elderly. In the included literature, postoperative complications of LAS include epilepsy, wound infection, fever, and DVT. The postoperative complication rate of LAS is 6.12%. Postoperative complications of GA target cognitive or motor deterioration, pulmonary infection, pleural effusion, cardiac complications, sepsis, acute kidney injury, bleeding, electrolyte disorder, hypotension, stroke, pseudomeningocele, subdural infection, pleural effusion, low hemoglobin levels, coma, fever, and systemic seizures. The postoperative complication rate of GA is 21.54%. According to our analysis, LAS can significantly reduce the incidence of postoperative complications compared with GA ($p < 0.0001$).

Craniotomy was the preferred surgical procedure for cSDH, although the mortality rate is up to 30%[24]. cSDH was treated by simple drilling and drainage, which later evolved to TDC or BHC, and the mortality rate has decreased significantly but has not been brought to zero. In addition to the changes in surgical methods, LAS plays a role in reducing mortality after cSDH drainage by reducing the incidence of postoperative complications. In a retrospective analysis by Wong et al[9], it was found that LAS significantly reduced the mortality of patients compared with GA. The causes of death may be associated with postoperative complications such as pulmonary infection, thrombosis, and underlying diseases. In Mahmood et al[11], regardless of the type of anesthesia, patient death may be associated with underlying diseases such as chronic kidney disease. Our analysis indicated that mortality was not significantly different between LAS and GA ($p = 0.48$).

In past studies[19,25,26], different drainage methods were shown to reduce the recurrence of cSDH. However, intracranial and extracranial communication, the introduction of a drainage tube, and other factors may pose a true or false risk of postoperative infection. It has been reported that the recurrence rate of cSDH after surgery is between 2.5% and 33%, and the recurrence rate increases with age[27,28]. The etiology of relapses is not fully understood. Many factors seem to contribute to the risk of relapse. In older patients with brain atrophy, a decrease in brain tissue elasticity due to cSDH oppression, the large residual subdural space after surgery, the use of antiplatelet agents, angiogenesis growth factors, and inflammatory cytokines, high levels of IL-6 in subdural fluid, and factors enhancing outer membrane VEGF and bFGF expression may lead to the recurrence of cSDH[3]. Recurrent cSDH presents a significant challenge to patient management.

Blaauw's study[29] showed no significant difference in the three-month recurrence rate between LA and GA. To reduce the objective factors of cSDH as much as possible, we analyzed the effects of LAS and GA on the recurrence of cSDH. No significant difference in cSDH recurrence was found between LAS and GA ($p = 0.66$).

Theoretically, if the total duration of surgery is reduced, the occurrence of surgery-related complications should reduce as well, leading to a reduction in LOS. There is likely to be an increased demand for post-anesthesia care units, and this is a potential advantage of LAS. Wong et al[9] and Surve et al[12] also seem to support the notion that LAS can reduce the LOS. According to our previous analysis, LAS can significantly reduce the total duration of surgery and postoperative complications, and theoretically, LOS will be shorter in the case of LAS. However, we found no significant difference in LOS between LAS and GA ($p = 0.14$).

There are some limitations to this meta-analysis. There is little literature available, and the available studies are prospective and retrospective cohort studies rather than randomized, matched, or paired studies between two patient groups. At the same time, the surgery should not be carried out blindly. Despite these limitations, we believe that the results of our meta-analysis may be useful to surgeons and anesthesiologists in their choice of anesthesia for surgical treatment of cSDH.

Conclusions

To our knowledge, this is the first meta-analysis assessing the differences between LAS and GA in the treatment of cSDH. Our analysis included three retrospective studies and one prospective study, most of which were of moderate quality. Although no randomized double-blind studies have been conducted, the available studies reflect the actual situation in the clinic and assist clinical decision makers.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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References

1) Seizeur R, Abed-Rabbo F, Obaid S, Saliou P, Simon A, Dam Hieu P, Magro E. Chronic subdural haematomas in elderly population. Neurosurgical aspects and focus on the single-burr hole technique performed under assisted local anaesthesia. Br J Neurosurg 2017; 31: 258-261.
2) Miah IP, Tank Y, Rosendaal FR, Peul WC, Dammers R, Lingsma HF, den Hertog HM, Jellema K, van der Gaag NA. Radiological prognostic factors of chronic subdural hematoma recurrence: a systematic review and meta-analysis. Neuroradiology 2021; 63: 27-40.
3) Yadav YR, Parihar V, Namdev H, Bajaj J. Chronic subdural hematoma. Asian J Neurosurg 2016; 11: 330-342.
4) Almenawer SA, Farrokhyar F, Hong C, Alhazzani W, Manoranjan B, Yarascavitch B, Arjmand P, Baronia B, Reddy K, Murty N, Singh S. Chronic subdural hematoma management: a systematic review and meta-analysis of 34,829 patients. Ann Surg 2014; 259: 449-457.
5) Gelabert-González M, Iglesias-Pais M, García-Allut A, Martínez-Rumbo R. Chronic subdural haematoma: surgical treatment and outcome in 1000 cases. Clin Neurol Neurosurg 2005; 107: 223-229.
6) Wang W, Feng L, Bai F, Zhang Z, Zhao Y, Ren C. The Safety and Efficacy of Dexmedetomidine vs. Sufentanil in Monitored Anesthesia Care during Burr-Hole Surgery for Chronic Subdural Hematoma: A Retrospective Clinical Trial. Front Pharmacol 2016; 7: 410.
7) Srivastava VK, Agrawal S, Kumar S, Khan S, Sharma S, Kumar R. Comparative Evaluation of Dexmedetomidine and Propofol Along With Scalp Block on Haemodynamic and Postoperative Recovery for Chronic Subdural Haematoma Evacuation Under Monitored Anaesthesia Care. Turk J Anaesthesiol Reanim 2018; 46: 51-56.
8) Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JP, Clarke M, Devereaux PJ, Kleijnen J, Moher D. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. Ann Intern Med 2009; 151: W65-94.
9) Wong HM, Woo XL, Goh CH, Chee PHC, Adenan AH, Tan PCS, Wong ASH. Chronic Subdural Hematoma Drainage Under Local Anesthesia with Sedation versus General Anesthesia and Its Outcome. World Neurosurg 2022; 157: e276-e285.
10) Certo F, Maione M, Altieri R, Garozzo M, Toccaceli G, Peschillo S, Barbagallo GMV. Pros and cons of a minimally invasive percutaneous subdural drainage system for evacuation of chronic subdural hematoma under local anesthesia. Clin Neurol Neurosurg 2019; 187: 105559.
11) Mahmood SD, Waqas M, Baig MZ, Darbar A. Mini-Craniotomy Under Local Anesthesia for

Chronic Subdural Hematoma: An Effective Choice for Elderly Patients and for Patients in a Resource-Strained Environment. World Neurosurg 2017; 106: 676-679.

12) Surve RM, Bansal S, Reddy M, Philip M. Use of Dexmedetomidine Along With Local Infiltration Versus General Anesthesia for Burr Hole and Evacuation of Chronic Subdural Hematoma (CSDH). J Neurosurg Anesthesiol 2017; 29: 274-280.

13) Friedrich JO, Adhikari NK, Beyene J. Ratio of means for analyzing continuous outcomes in meta-analysis performed as well as mean difference methods. J Clin Epidemiol 2011; 64: 556-564.

14) Guénot M. [Chronic subdural hematoma: historical studies]. Neurochirurgie 2001; 47: 461-463.

15) Yang W, Huang J. Chronic Subdural Hematoma: Epidemiology and Natural History. Neurosurg Clin N Am 2017; 28: 205-210.

16) Shim YS, Park CO, Hyun DK, Park HC, Yoon SH. What are the causative factors for a slow, progressive enlargement of a chronic subdural hematoma? Yonsei Med J 2007; 48: 210-217.

17) Edlmann E, Giorgi-Coll S, Whitfield PC, Carpenter KLH, Hutchinson PJ. Pathophysiology of chronic subdural haematoma: inflammation, angiogenesis and implications for pharmacotherapy. J Neuroinflammation 2017; 14: 108.

18) Uno M, Toi H, Hirai S. Chronic Subdural Hematoma in Elderly Patients: Is This Disease Benign? Neurol Med Chir (Tokyo) 2017; 57: 402-409.

19) Shapey J, Glancz LJ, Brennan PM. Chronic Subdural Haematoma in the Elderly: Is It Time for a New Paradigm in Management? Curr Geriatr Rep 2016; 5: 71-77.

20) Mori K, Maeda M. Surgical treatment of chronic subdural hematoma in 500 consecutive cases: clinical characteristics, surgical outcome, complications, and recurrence rate. Neurol Med Chir (Tokyo) 2001; 41: 371-381.

21) Mekaj AY, Morina AA, Mekaj YH, Manxhuka-Kerliu S, Miftari EI, Duci SB, Hamza AR, Gashi MM, Xhelaj MR, Kelmendi FM, Morina Q. Surgical treatment of 137 cases with chronic subdural hematoma at the university clinical center of Kosovo during the period 2008-2012. J Neurosci Rural Pract 2015; 6: 186-190.

22) Erol FS, Topsakal C, Faik Ozveren M, Kaplan M, Tiftikci MT. Irrigation vs. closed drainage in the treatment of chronic subdural hematoma. J Clin Neurosci 2005; 12: 261-263.

23) Rohde V, Graf G, Hassler W. Complications of burr-hole craniostomy and closed-system drainage for chronic subdural hematomas: a retrospective analysis of 376 patients. Neurosurg Rev 2002; 25: 89-94.

24) Sahyouni R, Mahboubi H, Tran P, Roufail JS, Chen JW. Membranectomy in Chronic Subdural Hematoma: Meta-Analysis. World Neurosurg 2017; 104: 418-429.

25) Santarius T, Kirkpatrick PJ, Ganesan D, Chia HL, Jalloh I, Smielewski P, Richards HK, Marcus H, Parker RA, Price SJ, Kirollos RW, Pickard JD, Hutchinson PJ. Use of drains versus no drains after burr-hole evacuation of chronic subdural haematoma: a randomised controlled trial. Lancet 2009; 374: 1067-1073.

26) Goyal RK, Nayak B, Maharshi R, Bidhar DD, Panchal S, Pathak HC. Management of Chronic Subdural Hematoma: Burr Hole versus Twist Drill - A Prospective Study. Asian J Neurosurg 2018; 13: 319-323.

27) Santarius T, Qureshi HU, Sivakumaran R, Kirkpatrick PJ, Kirollos RW, Hutchinson PJ. The role of external drains and peritoneal conduits in the treatment of recurrent chronic subdural hematoma. World Neurosurg 2010; 73: 747-750.

28) Chon KH, Lee JM, Koh EJ, Choi HY. Independent predictors for recurrence of chronic subdural hematoma. Acta Neurochir (Wien) 2012; 154: 1541-1548.

29) Blaauw J, Jacobs B, den Hertog HM, van der Gaag NA, Jellema K, Dammers R, Lingsma HF, van der Naalt J, Kho KH, Groen RJM. Neurosurgical and Perioperative Management of Chronic Subdural Hematoma. Front Neurol 2020; 11: 550.