3'2024
НЕЙРОХИРУРГИЯ | Russian Journal of Neurosurgery
ТОМ 26 Volume 26

Original report

DOI: https://doi.org/10.17650/1683-3295-2024-26-3-72-78

COMPARATIVE ANALYSIS OF TREATMENT RESULTS OF CRANIOTOMY AND EXTERNAL CLOSED DRAIN IN PATIENTS WITH CHRONIC SUBDURAL HEMATOMAS

E.D. Zykina[1], P.V. Ognev[2], K.N. Babichev[2,3], M.N. Kravtsov[2–4], V.E. Parfenov[2], V.A. Manukovskiy[2,4]

[1]*St. Petersburg State Pediatric Medical University, Ministry of Health of Russia; 2 Litovskaya St., Saint Petersburg 194100, Russia;*
[2]*I.I. Dzhanelidze St. Petersburg Research Institute of Emergency Medicine; 3A Budapeshtskaya St., Saint Petersburg 192242, Russia;*
[3]*S.M. Kirov Military Medical Academy, Ministry of Defense of Russia; 6 Akademika Lebedeva St., Saint Petersburg 194044, Russia;*
[4]*I.I. Mechnikov Noth-Western State Medical University, Ministry of Health of Russia; 41 Kirochnaya, Saint Petersburg 191015, Russia*

Contacts: Elizaveta Dmitrievna Zykina *zykina_01@bk.ru*

Aim. To conduct a comparative analysis of the treatment results of the patients with chronic subdural hematoma using two methods: closed external drainage and craniotomy.
Materials and methods. The data of 55 patients with chronic subdural hematoma operated in the I.I. Dzhanelidze St. Petersburg Research Institute of Emergency Medicine from 2019 to mid-2023 was analyses retrospectively. Depending on the treatment method, patients were divided into 2 groups: external subdural drains (n = 30, 55.5 %) and evacuation of hematoma *via* craniotomy (n = 25, 45.5 %). The patients in the groups were comparable in clinical features, radiological characteristics and the Charlson comorbidity index. In the postoperative period, the following were assessed: hematoma thickness and displacement of median structures, occurrence of surgical complications, and mortality.
Results. There were no differences between the groups in the midline shift, the frequency of postoperative complications, reoperation and deaths. The thickness of the hematomas according to the control computed tomography scans of the brain was lower in the craniotomy group, but this did not determine the outcome of treatment. Patients with a Charlson Comorbidity Index value of 4 points or higher were significantly more likely to have an unfavorable outcome. The sensitivity and specificity of the index in predicting an unfavorable outcome was 71.4 and 69.7 %, respectively.
Conclusion. There were no differences in the effectiveness of craniotomy and external subdural drains of chronic subdural hematoma. In this regard, it is necessary to give preference to minimally invasive methods of treatment. Assessment of the comorbid status allows predicting an unfavorable outcome of treatment.

Keywords: chronic subdural hematoma, drainage, comorbidity index

For citation: Zykina E.D., Ognev P.V., Babichev K.N. et al. Comparative analysis of treatment results of craniotomy and external closed drain in patients with chronic subdural hematomas. Neyrokhirurgiya = Russian Journal of Neurosurgery 2024; 26(3):72–8. (In Russ.).
DOI: https://doi.org/10.17650/1683-3295-2024-26-3-72-78

BACKGROUND

Chronic subdural hematoma (CSD) is a common neurosurgical pathology characterized by pathological blood accumulation in the subdural space. A special feature of CSD is the presence of a capsule with immature capillaries through which blood is exudated into subdural space. Gradual growth of hematoma volume underlies phasic disease progression: from clinical compensation (small volume) to gross decompensation associated with brain displacement. With increased human lifespan, the number of patients with CSD increases due to anticoagulant and antiaggregant therapy for concomitant pathology affecting the final treatment outcome [1–3]. Multiple methods of CSD treatment have been proposed (from conservative therapy to surgical drain) which testifies to unsatisfactory results and continued search for the “ideal” method.

Aim. to perform a comparative analysis of treatment results of patients with CSD using two methods: burr hole craniostomy and craniotomy.

MATERIALS AND METHODS

A retrospective analysis of data on 55 patients with CSD who underwent surgery at the I.I. Dzhanelidze Saint Petersburg Research Institute of Emergency Medicine between 2019 and the middle of 2023 was performed.

Verification of hematoma type (acute, subacute, chronic) was performed through analysis of medical documents and computed tomography (CT) data. Patients with acute and subacute subdural hematomas, patients who underwent neurosurgical intervention less than 6 months prior to hospitalization were excluded from the study.

Patients' characteristics. Depending on the type of surgical intervention, the patients were divided into 2 groups:

- 1st group: 25 (45.5 %) patients in whom operative intervention was performed through a trephination window (craniotomy);
- 2nd group: 30 (55.5 %) patients who underwent external closed drain.

Both groups contained more men than women: 25 (83.3 %) and 27 (90 %) men, respectively. Mean patient age in the 1st group was 62.6 years (95 % confidence interval (CI) 55.9–69.7); in the 2nd group, 66.1 years (95 % CI 60.5–71.8).

Etiology, structure and severity of neurological abnormalities in the patients with CSD at hospitalization are presented in Table 1. Table 2 shows brain CT data: hematoma characteristics and severity of herniation syndrome.

The percentage of bilateral CSDs was 14.5 % but in all cases surgery was performed only on one side.

Data on comorbidities in the patients of both groups are presented in Table 3.

Surgical intervention technique. All surgical interventions were performed under general anesthesia.

Craniotomy. In the projection of the thickest part of hematoma, osteoplastic trephination was performed. Mean size of the formed trephination window was 43.5 cm^2. Dissection of the dura matter and external capsule of the hematoma with blood clot aspiration were performed. Diastasis between the bone and brain allowed to perform revision and hematoma evacuation above the whole hemisphere. The dura matter was sutured completely closed, the bone was installed into its place.

Closed external drain. In the area of the thickest part of hematoma, a burr hole was made. The dura matter and external capsule of the hematoma were dissected crosswise. Blood clots were washed out from the subdural space with warm physiological solution, and a drain was installed attached to a closed system of active draining (for 3 days on average).

Treatment result analysis. In the postoperative period, hematoma thickness, midline shift, recurrence rate, surgical complications, duration of hospitalization, and death rates were evaluated.

Postoperative complications included formation of intracerebral hematomas, CSD transformation into an acute subdural hematoma, development of tension pneumocephalus, suppurative infectious complications (meningitis, postsurgical wound infection).

Statistical analysis. Statistical analysis of the data was performed using Microsoft Excel (MicrosoftR) and Statistica for Windows (Stat Soft Inc., USA) software. Analysis of differences was performed using non-parametric

Table 1. *Clinical and neurologic characteristics of patients at hospital admission, n (%)*

Parameter	Group 1 (*n* = 25)	Group 2 (*n* = 30)
Glasgow Coma Scale score: 15 14–13 12–11 10–8	 15 (60) 3 (12) 2 (8) 5 (20)	 21 (70) 6 (20) – 3 (10)
Cerebral symptoms	13 (52)	16 (53.3)
Motor abnormalities	6 (24)	7 (23.3)
Speech abnormalities	3 (12)	5 (16.7)
Brain stem symptoms*	5 (20)	3 (10)
Fact of injury	8 (32)	12 (40)

**Brain stem symptoms include anisocoria, convergent or divergent strabismus, vertical gaze palsy, absence of pupil light reflex, spontaneous nystagmus.*

Table 2. *Computed tomography data by patient groups*

Parameter	Group 1, Me [Q_1; Q_3]	Group 2, Me [Q_1; Q_3]	*p*
Hematoma volume, mL	100 [72.5; 127.5]	100 [70; 120]	0.899
Hematoma thickness, mm	19 [15; 25.5]	21 [15; 25]	0.746
Lateral shift, mm	10.5 [5; 14]	7 [4;11]	0.258

Table 3. *Patient distribution per concomitant pathology*

Parameter	Group 1 (n = 25)	Group 2 (n = 30)
Concomitant pathology, n (%):		
ischemic heart disease	6 (24)	17 (56.7)
hypertonic disease	10 (40)	18 (60)
cerebrovascular diseases	10 (40)	12 (40)
chronic alcoholism	4 (16)	3 (10)
constant atrial fibrillation	1 (4)	7 (23.3)
paroxysmal atrial fibrillation	1 (4)	–
diabetes mellitus	2 (8)	3 (10)
Therapy, n (%):	2 (8)	2 (6.7)
antiplatelet drugs	1 (4)	4 (13.3)
anticoagulants	–	1 (3.3)
combination of antiplatelet drugs and anticoagulants		
Mean (minimal–maximal) value of the Charlson Comorbidity Index*	3 (0–9)	3 (0–7)

**No differences in the severity of concomitant pathology evaluated per the Charlson Comorbidity Index were observed (p = 0.879).*

Table 4. *Analysis of postoperative data*

Parameter	Group 1 (n = 25)	Group 2 (n = 30)	p
Midline shift after surgery, Me [Q_1; Q_3], mm	4.75 [3; 6.4]	4.4 [2.1; 7.5]	0.857
Hematoma thickness after surgery, Me [Q_1; Q_3], mm	4.75 [3; 6.5]	8 [5.8; 12]	0.952
Postoperative complication rate, n (%):	7 (28)	10 (33.3)	0.670
formation of intracerebral hematomas	2 (8)	0	0.150
tension pneumocephalus	2 (8)	4 (13.3)	0.678
secondary purulent meningitis	0	1 (3.3)	0.357
acute subdural hemorrhage	2 (8)	4 (13.3)	0.678
postoperative wound abscess	1 (4)	1 (3.3)	0.895
Recurrence rate, n (%)	3 (12)	6 (20)	0.437
Mortality, n (%)	3 (12)	7 (23.3)	0.278

statistical methods, in cases of frequency data using contingency tables. Hypotheses were accepted if significance level was above 95 % (p <0.05). ROC curve for evaluation of diagnostic effectiveness of a prognostic model and determination of classification threshold value (cut-off point) was plotted.

RESULTS

There were no statistical differences in consciousness level, focal hemisphere and brainstem neurologic signs between the groups. As presented in Tables 2 and 3, the patient groups were similar in age, comorbidity index, hematoma volume and thickness, midline shift. Considering comparability of the groups, treatment outcomes could only depend on the type of surgical intervention. However, further comparison of the treatment results did not show any differences between groups in postoperative complication rate, midline shift severity, frequency of repeat interventions due to recurrence, duration of stay at the intensive care unit, and death rate. Control CT showed smaller thickness of hematomas in the craniotomy group, but it did not affect treatment results. Table 4 presents the result of comparison of the above listed data and treatment outcomes.

Despite a significant difference in absolute and relative values, no statistical significance in the death rate was shown (p = 0.278).

Therefore, based on the performed analysis, we can conclude that the two techniques have comparable effectiveness both in the context of outcomes and postoperative complications. While residual hematoma thickness was a little higher in the 2nd group, it did not affect treatment results. For the majority of complications, no statistically significant differences in their rates were observed. However, in the craniotomy group 2 cases of intracerebral hematomas were observed. Development of this complication can be explained by a sharp change in pressure gradient which in cases of abnormal autoregulation of the cerebral arteries in elderly patients leads to rupture of small cerebral arteries (vacuum hematomas). Rightfully, there is a difference between operative time for the 2 techniques (p = 0.001). However, differences in operative time and duration of anesthesia did not affect treatment outcomes in the study groups.

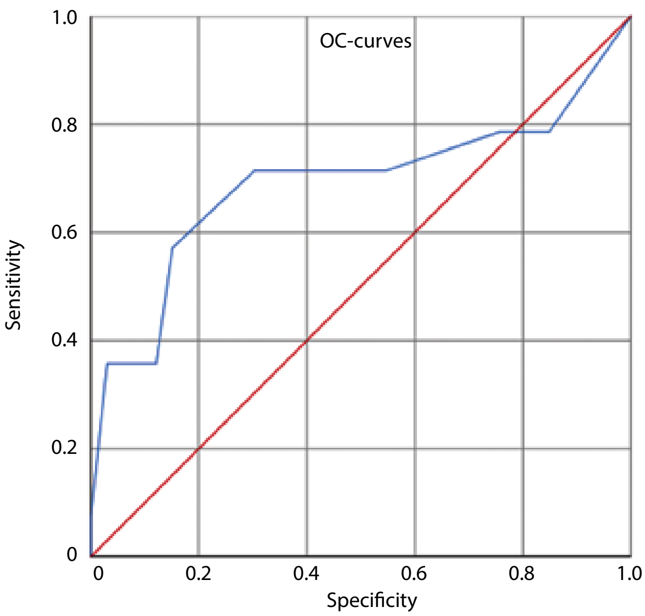

Fig. 1. *ROC analysis of dependence of unfavorable outcome on the Charlson Comorbidity Index*

To identify the predictors of unfavorable treatment outcome in patients with CSD, analysis of the effect of clinical presentation of the disease, comorbid status, and tomographic characteristics of the hematomas was performed. The analysis showed that such factors as patient's age, hematoma volume and thickness, midline shift before and after surgery did not predict unfavorable outcome. The only factor determining treatment outcome was the Charlson comorbidity index (see Fig. 1).

Area under the ROC curve corresponding to the association between comorbidity index and death was 0.689 ± 0.101 (95 % CI 0.491–0.887). The developed model was statistically significant ($p = 0.042$). Threshold value of the Charlson comorbidity index in the cut-off point was 4. For index equal to this value or above it, high risk of unfavorable outcome is predicted. Sensitivity and specificity of the method were 71.4 and 69.7 %, respectively.

Our study has significant limitations caused by retrospective data analysis and small sample size. Data presented in medical documents can be inaccurate, especially in the context of patient's comorbidity status. Additionally, we did not evaluate long-term treatment results (after 30 and 90 days) and did not compare other techniques of CSD treatment and their combinations: embolization and draining, twist-drill craniostomy, etc.

DISCUSSION

Chronic subdural hematomas are most common in elderly and senile patients [1–3]. Increased lifespan naturally leads to an increase in the number of such patients. Thus, according to the data of the Japanese National Registry (2005–2007), CSD incidence is 20.6 per 100,000 people on average but in the 70–79 years age group it amounts to 76.5 cases per 100,000 people [2]. Similar picture is observed in the USA: according to a study (2000–2012), CSD incidence was 79.4 cases per 100,000 people aged between 70 and 79 years [4]. Additionally, increased number of CSD cases in elderly patients determines the increased role of comorbidity [5–7]. Many patients have concomitant pathologies requiring anticoagulant or antiaggregant therapy. Therapy cancelation can negatively affect treatment outcome due to decompensation of the corresponding diseases while therapy continuation is associated with the risk of CSD development.

The search for the optimal treatment method remains very important. A large number of methods – from trephination with capsule removal to minimally invasive interventions aimed at dura devascularization – was proposed. It should be kept in mind that the pathophysiological basis of hematoma formation and growth is the presence of a capsule with a large number of "immature" capillaries and local hyperfibrinolysis. This leads to constant hemorrhages into the subdural space [8]. This theory is confirmed by the effectiveness of therapy using a drug with antifibrinolytic activity (tranexamic acid) and use of intravascular treatment techniques [9, 10]. Therefore, the main goal of surgical and/or conservative treatment is normalization of hemostasis in the hematoma cavity and its subsequent resorption. In this context, minimally invasive methods can be sufficient [10]. Widespread acceptance of external hematoma draining methods, rejection of large trephinations with capsule dissection have led to decreased death rates and increased numbers of favorable outcomes [8]. Our data also demonstrate that minimally invasive methods are not inferior to craniotomy even in patients with depression of consciousness. Moreover, external drain allows to decrease the frequency of intracerebral hematoma and tension pneumocephalus development.

Evaluation of the effect of concomitant pathology severity on treatment outcome was one of the goals of our study. Literature analysis showed that many authors consider the effect of comorbid pathology on treatment outcome, develop prognostic models [7, 11, 12]. We have chosen the Charlson comorbidity index as one of the most widely used indices for prognosis in patients with long follow-ups [6]. The Charlson comorbidity index is a point system evaluating age and presence of specific concomitant diseases. Calculation of the index involves summation of the points corresponding to comorbid diseases and adding 1 point for every decade after 40 years of life (i. e. 50 years – 1 point, 60 years – 2 points, etc.). In this pilot study, Charlson comorbidity index value of 4 was the threshold determining unfavorable outcome.

Unfortunately, Charlson comorbidity index has a number of shortfalls: it does not take into account the presence of stenocardia and heart failure stage, some other prognostically important diseases. However, none of the comorbidity indices takes into account all of the aspects.

In the future, a prospective study with evaluation of long-term outcomes will allow to study the effects of comorbid status and different combinations of minimally invasive treatment techniques in more detail.

CONCLUSION

No differences between craniotomy and external closed drain in treatment of patients with CSD were found. Therefore, minimally invasive treatment methods should be preferred. Moreover, the Charlson comorbidity index allows to predict the probability of unfavorable outcome in a patient with CSD. In patients with CSD and Charlson comorbidity index 4 or higher, unfavorable outcome is more common.

REFERENCES

1. Feghali J., Yang W., Huang J. Updates in chronic subdural hematoma: epidemiology, etiology, pathogenesis, treatment, and outcome. World Neurosurg 2020;141:339–45. DOI: 10.1016/j.wneu.2020.06.140
2. Karibe H., Kameyama M., Kawase M. et al. [Epidemiology of chronic subdural hematomas (In Japanese)]. No Shinkei Geka 2011;39(12):1149–53.
3. Toi H., Kinoshita K., Hirai S. et al. Present epidemiology of chronic subdural hematoma in Japan: analysis of 63,358 cases recorded in a national administrative database. J Neurosurg 2018;128(1):222–8. DOI: 10.3171/2016.9.JNS16623
4. Balser D., Farooq S., Mehmood T. et al. Actual and projected incidence rates for chronic subdural hematomas in United States Veterans Administration and civilian populations. J Neurosurg 2015;123(5):1209–15. DOI: 10.3171/2014.9.JNS141550
5. De Bonis P., Trevisi G., de Waure C. et al. Antiplatelet/anticoagulant agents and chronic subdural hematoma in the elderly. PLoS One 2013;8(7):e68732. DOI: 10.1371/journal.pone.0068732
6. Charlson M.E., Pompei P., Ales K.L., MacKenzie C.R. A New method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis 1987;40(5):373–83. DOI: 10.1016/0021-9681(87)90171-8
7. Hernández-Durán S., Behme D., Rohde V., von der Brelie C. A matter of frailty: the modified subdural hematoma in the elderly (mSHE) score. Neurosurg Rev 2022;45(1):701–8. DOI: 10.1007/s10143-021-01586-2
8. Likhterman L.B., Kravchuk A.D., Okhlopkov, V.A. Chronic subdural hematomas: challenges and solutions. Part 2. New concept for treatment of chronic subdural hematomas and the results. Klinicheskiy razbor v obshchey meditsine = Clinical Review for General Practice 2021;3:51–7. (In Russ.). DOI: 10.47407/kr2021.2.3.00050
9. Kageyama H., Toyooka T., Tsuzuki N., Oka K. Nonsurgical treatment of chronic subdural hematoma with tranexamic acid. J Neurosurg 2013;119(2);332–7. DOI: 10.3171/2013.3.JNS122162
10. Stanishevskiy A.V., Babichev K.N., Vinogradov E.V. et al. Middle meningeal artery embolization for chronic subdural haematoma. Case series and literature review. Zhurnal Voprosy Neirokhirurgii im. N.N. Burdenko = Burdenko's Journal of Neurosurgery 2021;85(5):71–9. (In Russ., in Engl.). DOI: 10.17116/neiro20218505171
11. Kwon C.-S., Al-Awar O., Richards O. et al. Predicting prognosis of patients with chronic subdural hematoma: a new scoring system. World Neurosurg 2018;109:e707–e14. DOI: 10.1016/j.wneu.2017.10.058
12. Chaliparambil R.K., Nandoliya K.R., Jahromi B.S., Potts M.B. Charlson Comorbidity Index and frailty as predictors of resolution following middle meningeal artery embolization for chronic subdural hematoma. World Neurosurg 2024;183:e877–e85. DOI: 10.1016/j.wneu.2024.01.049

Authors' contributions

E.D. Zykina: development of the concept and design of the study, examination of patients, collection and processing of material for analysis, analysis of the data obtained (including statistical), article writing;
P.V. Ognev: development of the concept and design of the study, examination of patients, analysis of the data obtained (including statistical), article writing;
K.N. Babichev: development of the concept and design of the study, analysis of the data obtained (including statistical), article writing;
M.N. Kravtsov: scientific consulting, scientific editing;
V.E. Parfenov, V.A. Manukovsky: scientific consulting.

ORCID of authors

E.D. Zykina: https://orcid.org/0009-0005-7161-3319
K.N. Babichev: https://orcid.org/0000-0002-4797-2937
M.N. Kravtsov: https://orcid.org/0000-0003-2486-6995
V.E. Parfenov: https://orcid.org/0000-0002-3221-5466
V.A. Manukovsky: https://orcid.org/0000-0003-0319-814X

Conflict of interest. The authors declare no conflict of interest.

Funding. The study was performed without external funding.

Compliance with patient rights and principles of bioethics. The protocol of the study was approved by the Committee on Biomedical Ethics of the I.I. Dzhanelidze St. Petersburg Research Institute of Emergency Medicine.

Article submitted: 05.04.2024. **Accepted for publication:** 05.06.2024. **Published online:** 00.00.0000.