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The use of dexamethasone therapy for conservative management of chronic subdural hematomas: a question about efficacy and safety

Omar El Farouk Ahmed*, Ahmed Nagaty, Mohamed Helmy and Shafik Tahseen El Molla

Abstract

Background Chronic subdural hematoma (CSDH) is a commonly encountered neurosurgical entity, particularly among the elderly population. Surgical intervention by trepanation or burr hole craniostomy remains the gold standard approach for symptomatic cases. However, despite the excellent outcome, the surgical pathway remains also associated with possible complications, some of which might be fatal, in addition to a recurrence rate of up to 25%. Dexamethasone (DXM) therapy was used as an alternative non-surgical approach, yet its clinical effectiveness remains controversial. Therefore, the objective of this study is to evaluate the outcome of DXM use for the management of chronic subdural hematomas with regard to the clinical results, safety, efficacy and potential incidence of complications.

Results This is a retrospective study of 30 patients, with symptomatic CSDH managed by the authors by DXM therapy protocol. Subjects were assessed upon admission then closely monitored to evaluate their response to conservative management, then followed up and their data were recorded at 2 weeks, 1 month, 3 months, and 6 months after protocol initiation. Clinical scoring systems included the Glasgow Coma Scale (GCS) and the Markwalder Grading Scale (MGS), whereas radiological evaluation consisted of serial Computerized tomography (CT)scans to assess CSDH changes between time of protocol initiation and over the same time intervals. There was a statistically highly significant improvement regarding the GCS and the MGS of the studied cases on comparing the starting values to those throughout the follow-up intervals at 2 weeks, 1 month, 3 months, or six months ($p=0.001$). Patients presented with a neurological deficit also showed a statistically highly significant improvement on comparing the values at the beginning of our study to those recorded at the third month or those at the sixth month ($p=0.001$).

Conclusions Our study concluded that dexamethasone use is a safe and effective choice for the management of chronic subdural hematoma with an acceptable success rate and a low incidence rate of serious complications. We do not advocate for the replacement of surgery by DXM treatment but to consider its possible role in selected cases. Larger series and further studies would be yet considered with longer follow-up periods.

Keywords Chronic subdural hematoma, Nonoperative management, Dexamethasone

*Correspondence:
Omar El Farouk Ahmed
omarelfarouk@hotmail.com
Department of Neurosurgery, Faculty of Medicine, Ain Shams University, Cairo, Egypt

Background

Chronic subdural hematoma (CSDH) is a commonly encountered neurosurgical clinical condition characterized by progressive blood accumulation in the subdural space leading to hemispherical compression and gradual

evolution of the associated symptoms. A head trauma weeks before patient presentation is a frequent antecedent [1]. The incidence rate of CSDH is 8.1 per 100,000 per year in Western countries in patients aged 65 years or older [2], yet it rises to 58 per 100,000 per year for patients aged 70 years or older [3], particularly in the presence of a history of chronic alcohol abuse or coagulation disorders [4].

The current gold standard approach to manage symptomatic CSDH cases remain through burr hole craniostomy or craniotomy in particular cases [1, 5, 6]. Nevertheless, and despite providing a satisfactory outcome in most patients, there is still a possibility of surgical complications and even mortality [7]; also, a recurrence rate up to 25% of cases was recorded by numerous studies [1, 8].

Taking into consideration the reasonable needs to propose less aggressive measures for managing CSDH, several studies conferred successful resolution of CSDH either spontaneously or after medical treatment even for severely impaired patients [1, 9].

Prominently, very few papers debated the advantages and drawbacks of surgical vs. medical therapy, and the literature concerning the use of non-surgical modalities for conservative management of CSDH comprised small case series with very limited clinical observations [9–12].

Nonoperative measures for the management of CSDH including hypertonic or hyperosmolar solutions, and systemic glucocorticoids have been used and noted with favorable results [1, 4, 9, 10].

The rationale for DXM use lies on the complex effects of corticoids over the clot membrane and neovascularization, subsequently, systemic steroid therapy has been proposed in CSDH as an alternative to surgical intervention in carefully chosen patients, thus avoiding many unnecessary surgical procedures [13, 14].

The objective of this study is to evaluate the outcome and efficacy of systemic DXM therapy for conservative management of CSDH with regard to the clinical results, safety, efficacy and potential incidence of complications.

Methods

This is a retrospective study, conducted between March 2020 to February 2022 on 30 patients, with symptomatic chronic subdural hematoma managed by the authors according to planned dexamethasone treatment protocol. Upon admission, all patients functional neurological status was assessed by the Glasgow Coma Scale [15] and the Markwalder Grading Scale [16] to provide the basic data concerning the patients level of consciousness together with presence or absence of a focal neurologic deficit at the beginning of our study.

The MGS is a validated grading system for the severity of neurological symptoms, it classifies the CSDH patients' neurological status based on a grading scheme into 5 grades as follows: grade(G) 0 that refers to a patient with no neurological deficits, G 1 which describes a patient who is alert and oriented or presented with mild symptoms for example headache or mild neurological deficits, G 2 that comprises disoriented patients with variable neurological deficits such as hemiparesis, G 3 which involves stuporous patients who are maintaining a response to noxious stimuli or those with severe focal signs such as hemiplegia, and finally G 4 that refers to patients with absent motor response, or in decerebrate or decorticate posturing.

Patients enrolled in this study were followed up and their data were recorded at 2 weeks, 1 month, 3 months, and 6 months after protocol initiation.

Our study inclusion criteria involved patients with a newly diagnosed symptomatic CSDH causing an attenuation in level of consciousness or any focal neurologic deficit including motor weakness or speech affection; with radiological results confirming the clinical diagnosis through non-contrasted cranial computerized tomography (CT)scans showing a hypodense or isodense hematoma in the subdural space. The patients' clinical presentation must be justified by the CSDH and their MGS at the beginning of the DXM treatment protocol is either 1 or 2; patients with MGS 0 were not included in our study since our strategy was not to treat asymptomatic CSDH, but to follow them up.

Whereas our study exclusion criteria also involved patients with MGS grade 3 or 4, patients with acute subdural hematoma, patient with history of hypersensitivity to DXM or gastric ulceration or bleeding, and patients with uncontrolled diabetes mellitus (DM).

Initial clinical evaluation included patients' demographics (age, sex), relevant past medical and surgical history including that of a relevant head trauma and other comorbidities (for example hypertension, DM, use of blood thinners), in addition to patients' clinical presentation and its duration including neurological examination and the assessment of the GCS and the MGS for every patient.

Study patients were evaluated at time of presentation, throughout their hospital stay, and during the follow-up period at 2 weeks, 1 month, 3 months and 6 months, where their GCS and MGS were also recorded and follow-up non-contrasted CT scans of the brain were done at the ward or the outpatient clinic after discharge to evaluate changes in both CSDH thickness and midline shift if present.

An informed consent was obtained from all patients or by their first-degree relatives prior to their assignment to the planned treatment protocol or in case their

condition progressed to require a surgical intervention, another consent for surgery was also signed.

Patients included in our study received their DXM treatment protocol as follows, a starting daily dosage of 8 mg (mg) every 12 h, whether through oral or intravenous routes during the first four days, where their neurological status was closely monitored daily to assess their initial response to corticotherapy; then the DXM dose is tapered by half every three days to reach a dose of 0.5 mg per day by the 19th day of their treatment plan before DXM administration is finally aborted on the twentieth day. A proton pump inhibitor (pantoprazole, 40 mg daily) was used during the DXM administration period to protect against gastric irritation or peptic ulceration.

A favorable outcome was described as an improvement in the GCS, the MGS, or both, by at least one point during the initial two weeks of treatment, in this case the treatment plan is continued as planned till the 20th day. However, the DXM therapy protocol was discontinued in case of clinical deterioration at any time after its initiation, described as one or more points rise in the patients' MGS or decline in their GCS in comparison to the baseline scores; also if patients' clinical condition remain unchanged two weeks after protocol initiation. Plan was also discontinued if the follow-up CT scan at two weeks showed an increase in the hematoma thickness, or in case of emergence of severe DXM related complications (for example gastric bleeding).

In any of these cases indicating DXM therapy protocol discontinuation, the reason for this was documented.

All patients were planned to remain hospitalized for at least 3 days after treatment initiation, until the treating doctor considered the clinical condition safe for discharge. During hospitalization period, all patients had a close monitoring for their vital parameters and blood glucose level; even at time of discharge, all patients were requested to continue monitoring of their blood glucose level at home and reporting the results at their follow-up time.

For patients who showed an unfavorable response to DXM therapy protocol, a surgical evacuation was planned through burr craniostomy (BHC), A single Burr hole on the corresponding site of the hematoma (unilateral or bilateral) was planned under general anesthesia. The burr hole place should be planned at the site of the maximum thickness of the hematoma.

A small scalp incision down to the periosteum was done, between one and two inches in length, preceded by local anesthetic infiltration of 10 ml (ml) lidocaine hydrochloride 2% at the incision site. Periosteum is cut using the diathermy knife to permit adequate skull bone exposure prior to allow burr hole creation using the Hudson brace and the Kerrison rongeur approximately an inch in diameter, dura matter, as well as dural flaps after durotomy are then cauterized using the bipolar cautery forceps. The hematoma should be subjected for non traumatizing slow and steady drainage by body temperature saline till the fluid comes out quite clear. Finally, a closed-system drainage (EG vac, size 12, made in Egypt) is applied outside the burr hole and exteriorized through a separate skin incision about an inch away before wound closure.

During their hospital stay, patients were requested to stay in a flat position for one day, then gradual head elevation follows by the next day prior patient ambulation. The drainage bag was kept below the level of the head with no negative pressure then it is removed between the second and the third day after surgery according to the drainage volume and the radiological findings. Antimicrobial prophylaxis was maintained as long as the catheter remained inserted. This group of patients remained under the same follow-up plan as those who showed a favorable response to the DXM plan for the same time period.

Data analysis was performed using the Statistical Package for Social Sciences, version 20.0 released 2011 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean ± standard deviation (SD). Qualitative data were expressed as frequency and percentage. The following tests were done: Chi-square ($\times 2$) test of significance was used in order to compare proportions between qualitative parameters. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following: probability value < 0.05 was considered significant; < 0.001 was considered as highly significant and > 0.05 was considered insignificant.

Results

All the patients' preoperative data were studied and analyzed. There were 19 (63.3%) males and 11 (36.7%) female patients. Their age ranged from 44 to 78 years, with a mean age of 62.60 (±9.86 SD) years. The commonest recorded medical risk factor was Smoking which was noted in 15 cases (50%), followed by hypertension noted in 13 patients (43.3%); a history of a relevant head trauma was in 18 patients (60%). Table 1 describes the demographic data and risk factors of the studied patients.

The main presenting symptom for our study cases was an altered level of consciousness which was recorded in 27 (90%), it ranged from a slight state of confusion to disorientation, since no stuporous or comatose patients were included in our study to begin with. Next it was the headache noted in 22 (73.3%) patients, followed by motor weakness and speech disturbance, each was recorded in 7

Table 1 Demographic data and risk factors of the studied patients

Baseline data	Total ($n=30$)
Sex	
Female	11 (36.7%)
Male	19 (63.3%)
Age (years)	
Range	44–78
Mean ± SD	62.60 ± 9.86
HTN	13 (43.3%)
DM	10 (33.3%)
Cardiac	8 (26.7%)
Blood thinners	10 (33.3%)
Smoker	15 (50.0%)
Previous head trauma	18 (60.0%)

HTN hypertension, *DM* diabetes mellitus, *n* number, *SD* standard deviation

(23.3%) patients, finally convulsions were recorded and in 6 (20%) patients.

Table 2A describes the GCS values for all our study subjects at the beginning of our treatment protocol and throughout the follow-up period. By evaluating these results, Table 2B shows that there was a statistically highly significant improvement regarding the GCS of the studied cases on comparing the starting values to those throughout the follow-up intervals ($p=0.001$), taking into consideration a statistically significant improvement on comparing the values between the first to sixth months ($p=0.009$). However, on comparing the GCS values between 2 weeks and one month, values between one and three months, and values between three and six months, there was no statistically significant difference.

Similarly, Table 3A describes the MGS values for all our study subjects at the start of our treatment protocol and throughout the follow-up period. Subsequently, Table 3B shows that there was a statistically highly significant improvement regarding the MGS values of the studied cases on comparing the initial ones to those throughout the follow-up intervals ($p=0.001$), yet there was a statistically significant improvement on comparing the values recorded on the second week to those at one month ($p=0.049$), and also the values between the first to sixth months ($p=0.002$). However, on comparing the MGS values between one month and three months, and values recorded at three and six months, there was no statistically significant difference.

Table 4 describes that our patients presented with a neurological deficit also showed a statistically highly significant improvement on comparing the values at the beginning of our study to those recorded at the third month or those at the sixth month ($p=0.001$). A statistically significant differences was also noted on comparing

Table 2 **A** GCS values throughout the study duration. **B** Comparison between GCS values among study group ($n=30$) throughout study duration

GCS	Day 1 ($n=30$) (%)	Day 14 ($n=30$) (%)	1 month ($n=30$) (%)	3 months[#] ($n=29$) (%)	6 months[#] ($n=29$) (%)
8	0 (0.0)	0 (0.0)	1 (3.3)	0 (0.0)	0 (0.0)
13	16 (53.3)	2 (6.7)	1 (3.3)	0 (0.0)	0 (0.0)
14	11 (36.7)	17 (56.7)	8 (26.7)	2 (6.9)	0 (0.0)
15	3 (10.0)	11 (36.7)	20 (66.7)	27 (93.1)	29 (100.0)

Comparison	Chi-square test	*p*-value
Day 1 vs. Day 14	16.746	< 0.001**
Day 1 vs. 1 M	27.274	< 0.001**
Day 1 vs. 3 M	41.426	< 0.001**
Day 1 vs. 6 M	48.122	< 0.001**
Day 14 vs. 1 M	7.186	0.066
Day 14 vs. 3 M	20.568	< 0.001**
Day 14 vs. 6 M	27.091	< 0.001**
1 M vs. 3 M	6.628	0.085
1 M vs. 6 M	11.639	0.009*
3 M vs. 6 M	0.518	0.472

Using: Chi-square test

GCS Glasgow Coma Scale, *n* number of patients, *M* months after protocol initiation

p-value > 0.05 is insignificant, **p*-value < 0.05 is significant, ***p*-value < 0.001 is highly significant

[#] one case was deceased

Table 3 **A** MGS values throughout the study duration. **B** Comparison between MGS values among study group ($n=30$) throughout study duration

MGS	Day 1 ($n=30$) (%)	Day 14 ($n=30$) (%)	1 month ($n=30$) (%)	3 months[#] ($n=29$) (%)	6 months[#] ($n=29$) (%)
0	0 (0.0)	3 (10.0)	10 (33.3)	17 (58.6)	24 (82.8)
1	11 (36.7)	22 (73.3)	18 (60.0)	12 (41.4)	5 (17.2)
2	19 (63.3)	5 (16.7)	1 (3.3)	0 (0.0)	0 (0.0)
3	0 (0.0)	0 (0.0)	1 (3.3)	0 (0.0)	0 (0.0)

Comparison	Chi-square test	*p*-value
Day 1 vs. Day 14	14.833	< 0.001**
Day 1 vs. 1 M	28.890	< 0.001**
Day 1 vs. 3 M	36.037	< 0.001**
Day 1 vs. 6 M	45.246	< 0.001**
Day 14 vs. 1 M	7.836	0.049*
Day 14 vs. 3 M	17.729	< 0.001**
Day 14 vs. 6 M	32.029	< 0.001**
1 M vs. 3 M	4.999	0.172
1 M vs. 6 M	15.100	0.002*
3 M vs. 6 M	2.996	0.084

Using: Chi-square test

GCS Markwalder Grading Scale (), *n* number of patients, *M* months after protocol initiation)

p-value > 0.05 is insignificant; **p*-value < 0.05 is significant; ***p*-value < 0.001 is highly significant

[#] one case of deceased

Table 4 Evaluation of neurological deficit progress among study group throughout study duration

Measurements	Chi-square test	*p*-value
Day 1 vs. Day 14	1.172	0.279
Day 1 vs. 1 M	1.875	0.171
Day 1 vs. 3 M	10.851	< 0.001**
Day 1 vs. 6 M	13.694	< 0.001**
Day 14 vs. 1 M	0.054	0.815
Day 14 vs. 3 M	4.484	0.034*
Day 14 vs. 6 M	6.816	0.009*
1 M vs. 3 M	3.423	0.064
1 M vs. 6 M	5.608	0.018*
3 M vs. 6 M	0.483	0.487

Using: Chi-square test

p-value > 0.05 is insignificant; **p*-value < 0.05 is significant; ***p*-value < 0.001 is highly significant

M months after protocol initiation

the number of patients having a neurological deficit estimated at second week to that at the third or sixth month ($p=0.034$ and 0.009, respectively), and on comparing between first and the sixth month as well ($p=0.018$). Yet no statistically significant difference was found on evaluating and comparing the number of patients with neurological deficit between other time intervals in our study.

Before starting our treatment protocol, Unilateral CSDH was present in 18 patients (60%), in contrast to 12 (40%) cases where the CSDH was bilateral on the on the initial CT scan; a midline shift was recorded in 14 (46.7%) patients, of whom 12 (85.7%) patients had that midline shift less than 5 mm (mm), and the remaining 2 (14.3%) patients had their midline shift between 5 and 10 mm. An average number of 4 to 6 CT scans of the brain for our study subjects was done throughout the DXM treatment plan. There was a statistically highly significant improvement considering the midline shift values on comparing the initial CT brain of the studied cases, before starting our protocol, to those noted at the third month or those at the sixth month ($p=0.001$). However, no statistically significant difference was recorded on comparing the initial midline shift values to those at two weeks or those at one month, or on comparing the values at the third month in contrast to the sixth month.

Figures 1 and 2 show examples of a good radiological outcome and complete resolution of the hematomas throughout the follow-up course.

Ultimately, nine (30%) patients among our study subjects required surgical intervention to evacuate their CSDH during the study duration denoting an unfavorable response to DXM therapy, causes of discontinuation of our treatment protocol included the deterioration of our patients' GCS or MGS in comparison to their baseline

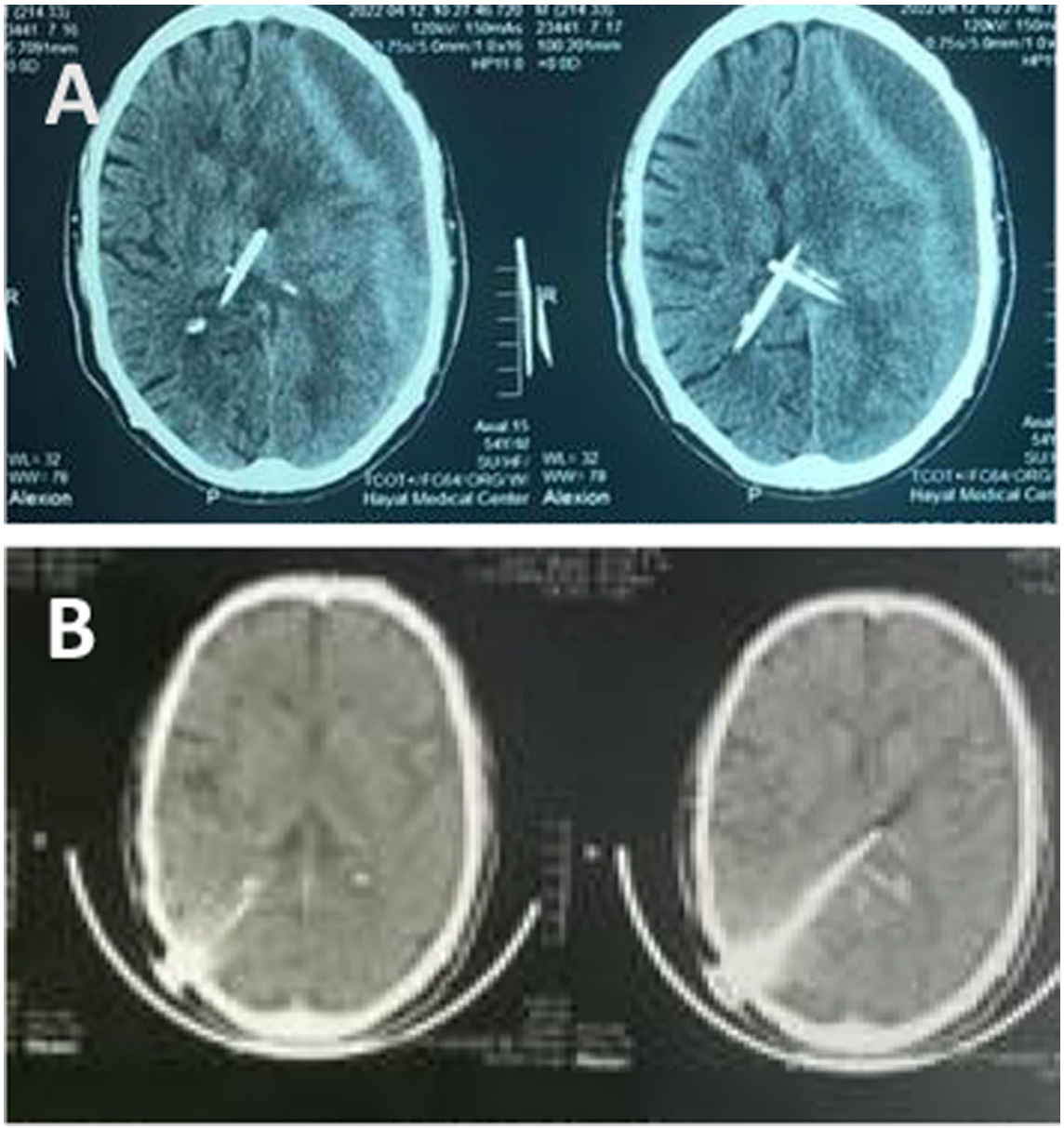

Fig. 1 **A** Initial CT brain of a 59-year-old male (formerly having a bilateral ventriculo-peritoneal shunts) presenting with depressed level of consciousness and hemiparesis, showing a left frontal unilateral CSDH producing midline shift. Dexamethasone treatment was initiated. **B** Complete resolution of the CSDH after 4 months follow-up

ones, increased hematoma thickness or non-improvement of the patients' condition.

Table 5 refers to number of days after the onset of our protocol where the progress of our patients' neurologic condition took place and necessitated abortion of the conservative plan to prevent any further deterioration.

Table 6A spots the light upon the GCS values for our study subjects who showed a favorable neurological outcome to DXM treatment protocol at the beginning of our treatment protocol and throughout the follow-up period. By evaluating these results, Table 6B shows that there was a statistically highly significant improvement regarding the GCS of these cases on comparing the starting values to those at one month, three months or six months, and similarly, a highly significant improvement on comparing GCS values at two weeks in contrast to those recorded at six months ($p=0.001$). However, on comparing the GCS values between 2 weeks and one month, values between one and three months, and values between three and six months, there was no statistically significant difference.

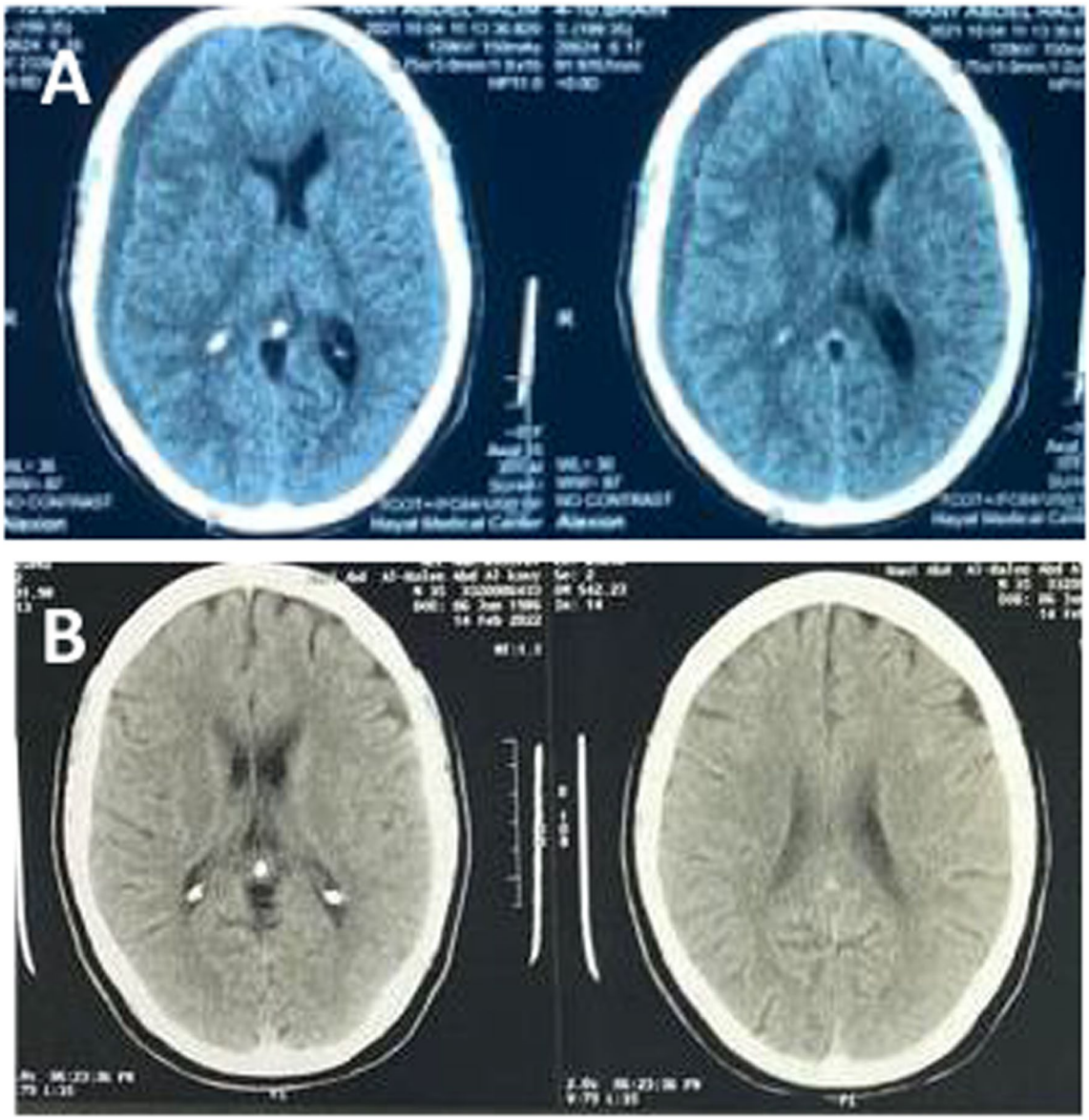

Fig. 2 **A** Initial CT brain of a 44-year-old male patient presenting with headache, vomiting, hemiparesis and drowsiness, showing a right fronto-parietal CSDH producing a midline shift. **B** Complete resolution of the hematoma 3 months after initiating dexamethasone treatment

Table 5 Response to DXM treatment protocol by our study group ($n = 30$)

Response to DXM treatment protocol	Total ($n = 30$) (%)
Favorable response	21 (70.0)
Unfavorable response	9 (30.0)
≤ 3 days	3/9 (33.3)
4–7 days	3/9 (33.3)
> 7 days	3/9 (33.3)

DXM dexamethasone, *n* number of patients

Likewise, Table 7A describes the MGS values for the same study group who showed a favorable neurological outcome to DXM treatment protocol at the beginning of our treatment protocol till the end of their follow-up period. By assessing these results, Table 7B shows that there was a statistically highly significant improvement regarding the MGS values of this group on comparing the initial ones to those recorded at one, three or six months, and also, a highly significant improvement on comparing MGS values at two weeks in contrast to those recorded at

Table 6 **A** GCS values for patient with a favorable neurological outcome ($n=21$) throughout study duration. **B** Comparison between GCS values for patient with a favorable neurological outcome ($n=21$) throughout study duration

GCS	Day 1 (%)	Day 14 (%)	1 month (%)	3 months (%)	6 months (%)
13	8 (38.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
14	10 (47.6)	11 (52.4)	6 (28.6)	1 (4.8)	0 (0.0)
15	3 (14.3)	10 (47.6)	15 (71.4)	20 (95.2)	21 (100.0)
Measurements			**Chi-square test**		***p*-value**
Day 1 vs. Day 14			11.817		0.003*
Day 1 vs. 1 M			17.000		< 0.001**
Day 1 vs. 3 M			27.929		< 0.001**
Day 1 vs. 6 M			31.500		< 0.001**
Day 14 vs. 1 M			1.581		0.209
Day 14 vs. 3 M			9.450		0.002*
Day 14 vs. 6 M			12.317		< 0.001**
1 M vs. 3 M			2.743		0.098
1 M vs. 6 M			4.861		0.028*
3 M vs. 6 M			0.477		0.490

Using: Chi-square test

GCS Glasgow Coma Scale, *n* number of patients, *M* months after protocol initiation

p-value > 0.05 is insignificant, *p-value < 0.05 is significant, **p-value < 0.001 is highly significant

Table 7 **A** MGS values for patient with a favorable neurological outcome ($n=21$) throughout study duration. **B** Comparison between MGS values for patient with a favorable neurological outcome ($n=21$) throughout study duration

MGS	Day 1 (%)	Day 14 (%)	1 month (%)	3 months (%)	6 months (%)
0	0 (0.0)	2 (9.5)	8 (38.1)	11 (52.4)	17 (81.0)
1	11 (52.4)	18 (85.7)	13 (61.9)	10 (47.6)	4 (19.0)
2	10 (47.6)	1 (4.8)	0 (0.0)	0 (0.0)	0 (0.0)
Measurements			**Chi-square test**		***p*-value**
Day 1 vs. Day 14			11.053		0.004*
Day 1 vs. 1 M			18.167		< 0.001**
Day 1 vs. 3 M			21.048		< 0.001**
Day 1 vs. 6 M			30.267		< 0.001**
Day 14 vs. 1 M			5.406		0.067
Day 14 vs. 3 M			9.516		0.009*
Day 14 vs. 6 M			21.751		< 0.001**
1 M vs. 3 M			0.384		0.535
1 M vs. 6 M			6.325		0.012*
3 M vs. 6 M			2.679		0.102

Using: Chi-square test

GCS Markwalder Grading Scale, *n* number of patients, *M* months after protocol initiation

p-value > 0.05 is insignificant, **p*-value < 0.05 is significant, ***p*-value < 0.001 is highly significant

six months ($p=0.001$). Yet there was a statistically significant improvement on comparing the values recorded on the first day to those at two weeks ($p=0.004$), the values at the second week to those at three months ($p=0.009$), and also the values between the first to sixth months ($p=0.012$). However, on comparing the MGS values at two weeks to those at one month, values at one month to those at three months, and values recorded at three months to those at six months, there was no statistically significant difference.

Hospitalization ranged from 3 days up to 36 days with a mean value of 11.77 (±7.09 SD). Unfortunate side effects to DXM treatment protocol took place in a total number of 8 (26.7%) patients, luckily they consisted of non serious complications including four cases of mild hyperglycemia, two cases of mild gastritis and a single case of oral candidiasis, where all were easily treated medically with no further sequalae. However, a single case had severe hyperglycemia and required insulin therapy.

Our study had a single (3.3%) mortality case, a 72 years old gentleman presented with confusion and expressive dysphasia as a result of a unilateral CSDH with a midline shift of almost 2–3 mm. He received his DMX treatment protocol and showed a good initial response by progressive improvement of his mental state as well as speech function. Surprisingly, a rapidly progressive deterioration in his level of consciousness occurred 17 days after the initiation of his treatment protocol and his CT scan of the brain did not show an increase in his CSDH size or the midline shift. Urgent evacuation by BHC was done yet the patient did not show a postoperative improvement despite his postoperative CT scan revealed a complete hematoma evacuation. The patient was deceased on the 22nd day.

Discussion

Neurosurgeons around the world are quite familiar with symptomatic chronic subdural hematoma, it is considered as a frequently encountered clinical scenario that demands prompt evaluation prior to a neurosurgical intervention plan which is often in the form of surgical interference possibly on an emergency basis particularly for patients with persistent symptoms or progressive neurological deficits. Currently, burr hole craniostomy and twist drill craniostomy are the most commonly applied surgical approaches [1, 6].

Even though a direct head trauma plays a substantial role in the incidence and expansion of CSDH, there could be no history of an antecedent head injury in up to 50% of patients [17].Inflammation has been discussed as a crucial element in the blossoming of CSDH since fluid collection and new membrane growth could be induced by a long term inflammatory response that involves angiogenesis and growth factors, hyperfibrinolysis, coagulopathy, and exudation to mediate for the pathology of CSDH [18].

Aside from surgical interventions, conservative management through pharmacologic therapies such as glucocorticoids were discussed to manage CSDH. Bender and Christoff discussed the role of steroid therapy in the management of CSDH where it was used in conjuncture to mannitol and bed rest [19].

In their study regarding the use of steroids as a primary non-surgical management protocol in CSDH back in 1987, Pichert and Henn reported that 83% of their study subjects were eventually symptom free [20].

Numerous studies postulated that a beneficial role for DXM could be attained through its ability to inhibit the inflammatory response and proper membrane production, hence prevent clot expansion in CSDH [21]; however, the use of DXM remained controversial taking into consideration the possibility of associated side effects including hyperglycemia, gastric irritation or ulceration, gastric bleeding, and infections [22].

Therefore, we conducted this study to discuss the clinical safety and effectiveness of DXM treatment for CSDH patients to generate data that might aid surgeons make a better clinical judgement and develop an optimal plan, and to assess our results in contrast to the literature since it was clear that the DXM use has shown a considerable variability between surgeons and has an inadequate evidence of effectiveness for its regular use in these patients. Our study was conducted on 30 patients with symptomatic newly diagnosed CSDH as confirmed by non-contrasted cranial CT upon admission, with their MGS at the beginning of the DXM treatment protocol being either 1 or 2; then assessed throughout the follow-up period. The mean age of our study cases was 62.60 (±9.86 SD) years; there was a male predominance as of 63.3% males and 36.7% female patients. Follow up assessment for our patients was conducted through the evaluation of the GCS and MGS in addition to serial radiological assessment by non-contrasted CT scans of the brain during hospitalization and along the follow-up period after discharge to evaluate changes in CSDH thickness and midline shift.

Our DXM treatment protocol consisted of a starting daily dosage of 8 mg every 12 h for the first four days then was tapered by half every three days to be finally aborted on the twentieth day; both Miah and colleagues [23], in addition to Parajuá and colleagues [24] used the same protocol in their studies, while Sun and colleagues [10] used a DXM dose of 4 mg every 6 h for 21 days. Other studies suggested different daily doses including Bender and Christoff [19] who used prednisone in a daily dose of 60 mg for 21 days, Rudiger and colleagues [12] who used a DXM dose of 4 mg every 12 h, and Delgado-López and colleagues [18] who applied a daily dose of 4 mg every 8 h that is slowly tapered by 1 mg per day every three days until complete withdrawal.

There was a statistically highly significant improvement regarding the GCS and the MGS values of the studied cases on comparing the initial ones to those recorded throughout the follow-up intervals, also, our patients presented with a neurological deficit showed a

statistically highly significant improvement at the third month and the sixth month of the DXM treatment plan. A statistically highly significant improvement considering the midline shift on cranial CT was also noted at the third and the sixth month in comparison to the starting time of their treatment protocol.

Twenty-one (70%) patients among our study subjects showed a favorable response to DXM therapy and did not need surgical intervention to evacuate their CSDH during our study duration. Delgado-López and colleagues [18] described a failure rate to DXM monotherapy in only 25% of his study patients that necessitated a surgical evacuation. Also, Sun and colleagues [10] study revealed a favorable clinical outcome at 6 months in 88% of their cases after DXM monotherapy; they also reported a success rate of 91% for DXM therapy adjunctive to surgery compared to 77% in response to surgery alone and 50% following observation only.

Rudiger and colleagues [12] reported the case of a seventy-six-year-old diabetic patient presented with altered level of consciousness and ataxia as a result of a bilateral CSDH who could not be subjected for surgical evacuation due to an anesthetic contraindications. On applying their DXM treatment protocol, the patient's condition showed progressive clinical improvement and his brain CT was normal after 6 weeks.

Bender and Christoff [19] stated that 37% of their cases required surgical intervention following a non successful DXM therapy protocol whereas Parajuá and colleagues [24] described that all their cases fully recovered.

In accordance with our results, Fountas and colleagues [21] pointed to a successful outcome in 70% of their cases treated with DXM monotherapy, yet they stated that the number of their study cases was sort and more studies are required for more secure results. Delgado-López and colleagues also denoted that at least two thirds of their study subjects were successfully managed with dexamethasone alone [18]. Holl and colleagues [25] noted that more than one third of their study patients with CSDH who were primarily treated with DXM required additional surgery, particularly those with larger hematomas or among patients who were more severely affected. Whereas Yao and colleagues [26] concluded they had not enough evidence to support that DXM therapy can be used as an effective substitute to surgery, yet it might be used as an adjuvant to improve the surgical therapy by reducing recurrence.

A favorable outcome was still obtained in patients presented with a deteriorated level of consciousness, a focal neurologic deficit and also in those who harbored a CSDH that induced a mass effect and a considerable midline shift. Subsequently, the presence of midline shift did not preclude success of the medical treatment nor was it linked to a worse final consequence, independently of the patients' response to the DXM treatment protocol. We noted a significant improvement in both clinical and radiological data of our study patients in response to the DXM treatment protocol, even if a disparity was recorded between the hematoma resolution on one hand and the pace of clinical improvement on the other hand, since most of our cases experienced a clinical improvement while it might take months for the hematoma to resolve completely as well as the midline shift. This comes in accordance with Parajuá and colleagues [24] results that described an immediate clinical improvement for their study patients after steroids treatment protocol initiation whereas the CSDH radiological resolution took place between 4 and 6 months after corticotherapy.

Hospitalization ranged from 3 days up to 36 days with a mean value of 11.77 (±7.09 SD), in contrast to a median hospital stay of 6 days (range 1 to 41 days) by Delgado-López and colleagues [18]. We believe that this result could be attributed to the longer hospital stay of patients with a higher MGS or lower GCS upon presentation who were intentionally kept under close monitoring for a longer duration, in addition to patients with relatively larger CSDH. Also, it could be referred to the longer hospital stay of cases who showed a relatively delayed improvement following surgery and subsequently required hospitalization for a longer period, and patients who had a later deterioration of their clinical condition after the beginning of their DXM treatment protocol necessitating surgery.

Our study depicted DXM relate complications in 8 (26.7%) patients, in accordance with Delgado-López and colleagues [18] who recorded a complication rate of 27.8% in their study; and despite the overall morbidity incidence was not low, yet the overall complications associating DXM treatment in both studies were not grave involving mainly hyperglycemias, gastric irritation, and infections that could be safely treated in the majority of patients. However, Delgado-López and colleagues [18] also recorded a number of crucial complications including a single case of severe gastric bleeding that required endoscopic management, three cases of cardiac complications, and three cases who had thromboembolic complications. No significant complication from steroid therapy was documented by Sun and colleagues [10] as well. Each of these three studies had a single mortality case recorded.

From our point of view, it is of great value to weigh up the possibility of providing the patient with a less invasive approach in the form of a conceivable conservative treatment plan before putting the surgical option into consideration as long as it would not put the patient through a hazard of morbidity or failure.

Conclusions

Our study concluded that dexamethasone use is a safe and effective choice for the management of chronic subdural hematoma with an acceptable success rate and a low incidence rate of serious complications. We do not advocate for the replacement of surgery by DXM treatment but to consider its possible role in selected cases. Larger series and further studies would be yet considered with longer follow-up periods.

Abbreviations

CSDH	Chronic subdural hematoma
DXM	Dexamethasone
GCS	Glasgow Coma Scale
MGS	Markwalder Grading Scale
CT	Computerized tomography
G	Grade
DM	Diabetes mellitus
Mg	Milligrams
BHC	Burr craniostomy
Ml	Milliliters
SPSS	Statistical Package for the Social Sciences
HTN	Hypertension
N	Number of patients
SD	Standard deviation
mm	Millimeters
M	Months after protocol initiation

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Author contributions

OE: main author and corresponding author; AN: co-author; MH: co-author; SE: co-author. The study design, execution and follow up of the clinical cases, data analysis and results formulation, and writing of the manuscript, were all the joint work of all the authors. All authors have approved the manuscript for submission. The manuscript has not been published, or submitted for publication elsewhere. All authors read and approved the final manuscript.

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Availability of data and materials

All the raw data and results of the statistical analysis are available with the authors and ready to be shared with authorized personnel upon request, however, for reasons of patency protection it was not submitted with the manuscript.

Declarations

Ethics approval and consent to participate

This research was conducted upon obtaining the approval of the ethical committee of the Faculty of Medicine—Ain Shams University, in January 2020. Reference number: not available. Since this study involved human subjects, an informed written consent was signed and acquired from all the participants or their legal guardians in accordance with the ethical committee recommendations.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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