

Original Research

## Epidemiological and Therapeutic Aspects of Depressed Skull Fractures

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### ABSTRACT

**Objective:** To describe the epidemiological, clinical, therapeutic, and evolutionary characteristics of depressed skull fractures in our hospital.

**Materials and Methods:** This was a 15-month prospective descriptive study involving all patients operated on for a depressed skull fracture. Recruitment was carried out after obtaining the consent of the patient or the person accompanying him/her. The clinical diagnosis was confirmed by a cerebral CT scan.

**Results:** During the study period, depressed skull fractures accounted for 16% of head injuries. The average age of the patients was 27 years. Males predominated (66.7%). Apprentice motorbike mechanics were the most affected with 20.4%, followed by students with 18.5%. Road traffic accidents and intentional assault and battery were the main causes of trauma, with 37.9% and 29.6% respectively. Headache was present in all patients admitted to emergency departments, followed by scalp wounds (63.5%) and hemiparesis (45.9%). Cerebral CT scans revealed an open embracing fracture in 63 patients (58.3%). Ping-Pong ball fractures were found in 11.1%. 42.6% of patients had associated intracranial lesions. Surgery was performed through a single trepan hole in 49% of patients. A craniotomy with bone flap replacement was performed in 34.3%. At 6 months, 77.3% of patients had a favorable outcome; 16.5% had a persistent motor deficit and 3.1% of patients were taking anti-epileptic drugs. Mortality was 2.06%.

**Conclusion:** Depressed skull fractures are pathologies that are sometimes considered trivial, even though they are responsible for significant disability. Emphasis must be placed on prevention to achieve better results.

**Keywords:** Head trauma, depressed skull fractures, road accident, craniectomy, cerebral contusion.

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## INTRODUCTION

Head injury is a major public health problem because of the morbidity and mortality associated with it.<sup>1,2,3</sup> The depressed skull fractures are injuries to the skull that may occur during head trauma, with or without underlying injuries. It is a depression of the skull which may involve the external table, the internal table, and the diploe. In addition to its aesthetic appearance, the presence of an embasure fracture may expose patients to other complications arising from underlying cerebral lesions. Several surgical techniques are available. They are used according to the type of depressed fracture, the patient's condition, and the quality of the technical facilities available. Results will depend on the patient's neurological condition and the quality and earliness of treatment.

The objectives of this work were to: Determine the frequency and mechanisms of occurrence of depressed skull fracture at Gabriel Touré Teaching Hospital; Report the clinical aspects of patients with depressed skull fractures; Describe the types of depressed skull fractures and associated intracranial lesions; Evaluate the post-treatment evolution of patients treated for this pathology.

## MATERIALS AND METHODS

### Study Setting and Duration

This was a prospective descriptive study carried out in the emergency and neurosurgery departments of the Gabriel Touré Teaching Hospital in Bamako. It was carried out over 15 months, from March 2023 to May 2024.

### Sampling Technique

This was a non-probability convenience sampling technique, which involved recording interview data, clinical examination, and brain CT scan results on a survey form. These data were collected from head injury patients with depressed skull fractures who presented to the emergency department or

neurosurgical consultation room during the study period.

### Inclusion Criteria

The study included patients of both sexes and all ages treated for a depressed skull fracture of the cranial vault; patients or those accompanying them who had given informed consent; patients in whom a cranial CT scan had made it possible to diagnose the depressed skull fracture; and patients who had accepted the principles of the surgical treatment and regular follow-up.

### Exclusion Criteria

Excluded from the study were head trauma patients who did not have a fractured embolus; patients who did not have a CT brain scan; patients who refused medical treatment or were discharged against medical advice (for whatever reason); patients in whom consent was not obtained; patients who have undergone conservative (non-surgical) treatment and patients who did not follow up after hospitalization.

### Data Collection Tool

Sociodemographic (age, gender, occupation), clinical, radiological (CT), therapeutic and evolutionary parameters were studied. The data collected were processed in Microsoft Excel 2020 and entered in Microsoft Word version 2020.

### Data Analysis

The mean and extremes of quantitative variables were calculated. For qualitative variables, their numbers and frequencies were obtained. We did not apply statistical tests of significance or comparison to our data.

## RESULTS

### SOCIODEMOGRAPHIC ASPECTS

During the study period, 674 patients with cranial trauma were identified, including 108 cases of cranial vault fracture. This represents a frequency of 16%. The average age of the patients was 27, with extremes of 2 and 71 years. Male predominance was 66.7% (72 cases), with a sex ratio of 2. Apprentice motorcycle mechanics were the most affected with 20.4%, followed by students at 18.5% and blue-collar workers at 13.9% (Table 1).

### Clinical Data

#### - Mechanism of Head Injury

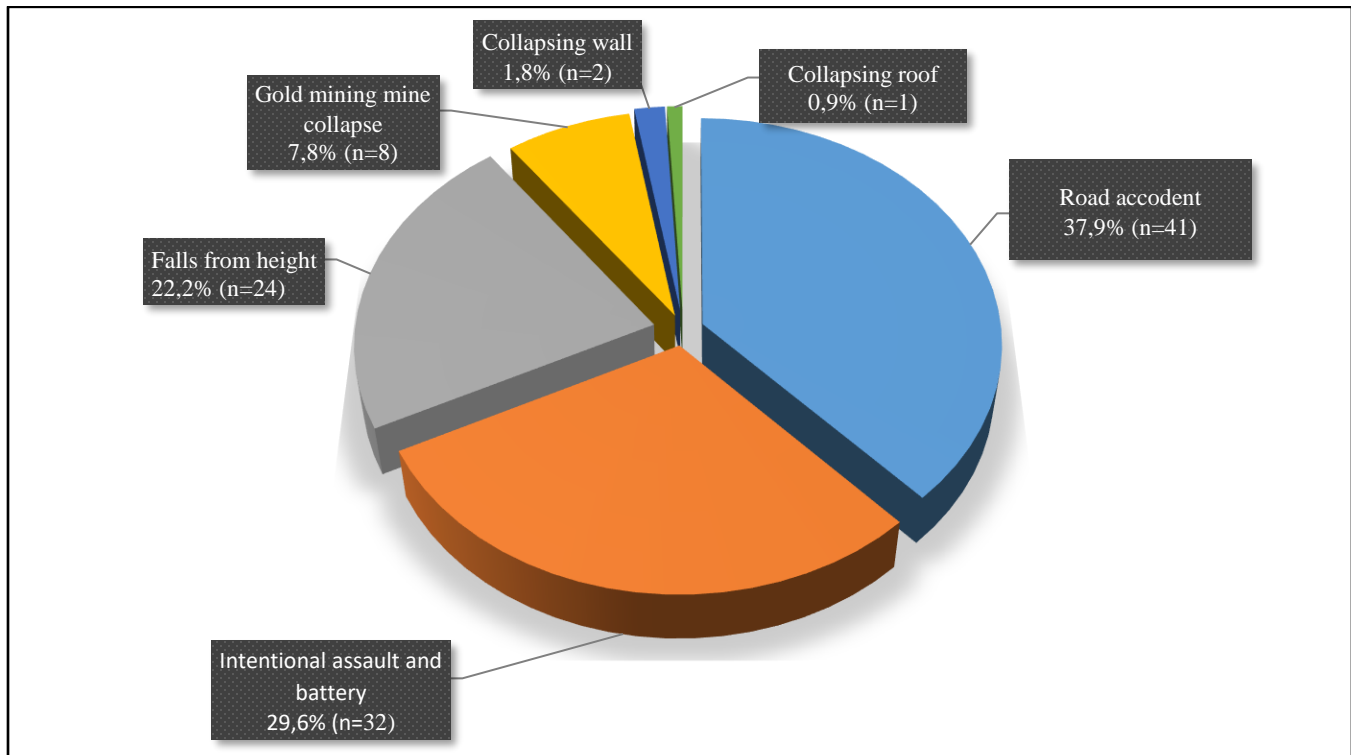
Road traffic accidents accounted for 37.9% of head injuries. Intentional assault and battery and falls from a height accounted for 29.6% and 22.2% respectively. Figure 1 shows the distribution of patients according to the mechanism of

occurrence of the head injury causing the depressed skull fracture.

In the case of fractures caused by road traffic accidents, 77.3% involved a motorcycle (17 patients). In the case of assault and battery, the

**Table 1:** Patient representation by professional activity (occupation).

Occupation	Number	Frequency (%)
Apprentice motorcycle mechanic	22	20,4
University's students	20	18,5
Workers	15	13,9
Street sellers	12	11,1
School children	9	8,3
High School students	8	7,4
No profession	7	6,5
Housewives	6	5,5
Unemployed graduates	4	3,7
Military	2	1,8
Private Security agents	2	1,8
Nurse	1	0,9



**Figure 1:** Distribution of patients by mechanism of head injury.

the object used was known in 90.6% (29 cases); it was a stick in 37.9% (11 cases), a stone in 24.1% (7 cases), an iron bar in 20.7% (6 cases), a broken bottle 13.8% (4 cases) and an unspecified metal object 3.4% (1 case). Regarding falls from heights, 8 patients (33.3%) fell down stairs; there were 6 cases of falling from the arms of a supporting person (25%), 4 cases of falling from trees (16.7%), 3 cases of falling from a roof (12.5%), 2 people had fallen from scaffolding (8.3%) and one case of falling from a wall (4.2%).

**- Clinical Details**

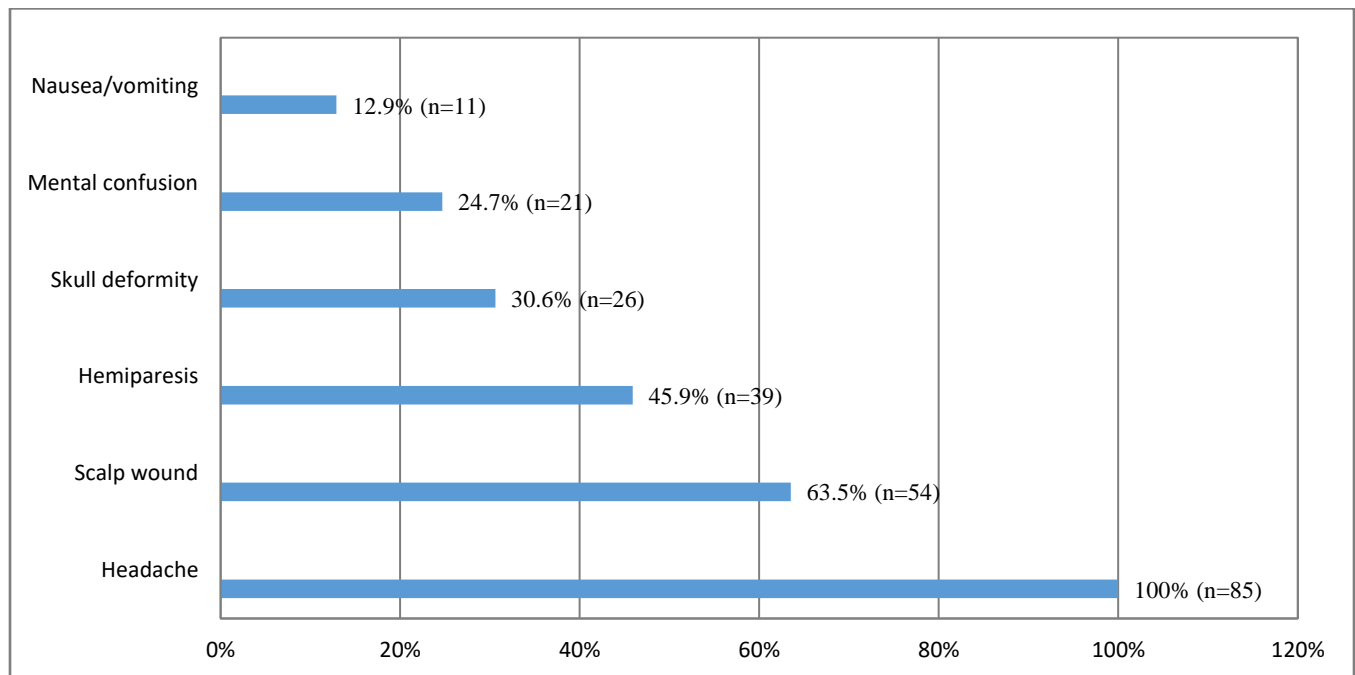
Seventy-eight point seven percent of patients (85 cases) were seen in the emergency department, while the remainder were seen on an outpatient basis. For emergency admissions, patients were brought in by the fire department in 34.1% (29 cases), personal vehicles in 29.4% (25 cases), and public transport (cab, minibus) in 22.4% (19 cases). In 12 cases, the mode of transport was unknown. The clinical picture varied considerably according to the patient's mode of admission. Headache was

present in all patients admitted via the emergency department, followed by scalp wounds (63.5%), hemiparesis (45.9%), cranial vault deformation, and mental confusion in 30.6% and 24.7% respectively (Figure 2).

Clinical signs in outpatients included headache 69.6% (16 cases), hemiparesis 52.2% (12 cases), scalp wounds and skull deformity 39.1% each (9 cases), mental confusion 21.7% (5 cases) and comitial seizures 17.4% (4 cases). Four patients had associated traumatic lesions (3.7%). These were forearm trauma 1.8% (2 cases), closed elbow, and leg trauma one case each (0.9%).

**Radiological Results**

Cerebral computed tomography (CT scan) revealed an open embracing fracture in 63 patients (58.3%). Ping-Pong ball fractures were found in 11.1% of patients (12 cases), all children. Comminuted and stair-step fractures were diagnosed in 96 patients (88.1%). Fractures were parietal (Figure 1) in 44.4%, followed by frontal (Figure 2) and frontoparietal in 31.5% and 16.7%

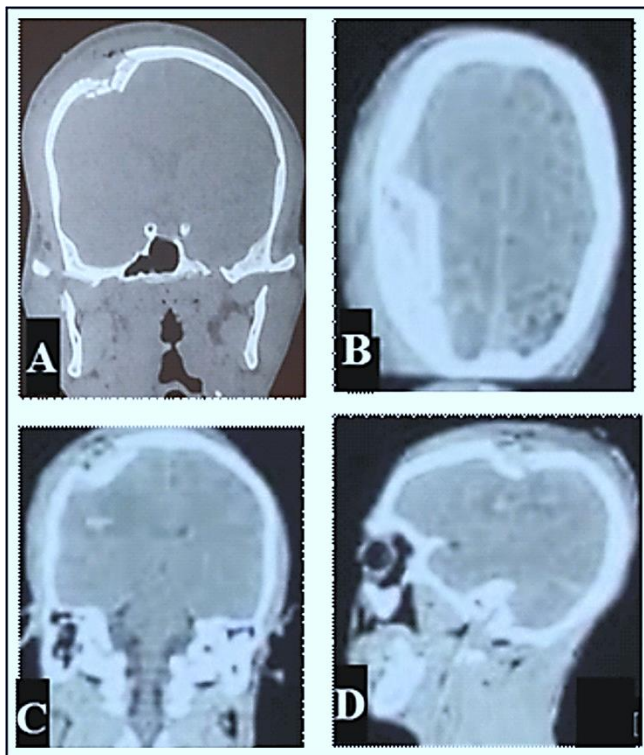


**Figure 2:** Clinical signs of patients seen in the emergency department.

respectively (Table 2).

**Table 2:** Depressed skull fractures by location on craniocerebral CT scan.

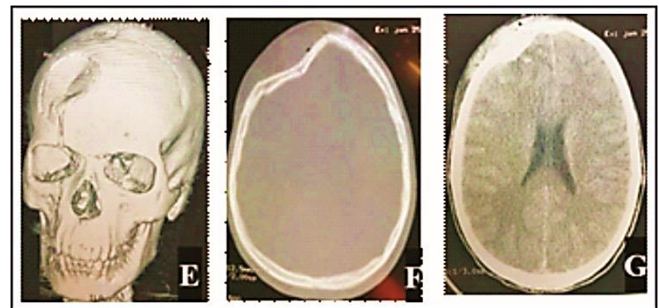
Depressed Skull Fracture Location	Number	Frequency (%)
Parietal	48	44,4
Frontal	34	31,5
Frontoparietal	18	16,7
Parieto-temporal	8	7,4



**Figure 3:** Right parietal depressed skull fracture.  
**A:** Coronal reconstruction, bone window.  
**B:** Axial section, parenchymal window.  
**C:** Coronal reconstruction, parenchymal window (fracture with cerebral contusion).  
**D:** Sagittal reconstruction, parenchymal window (fracture with cerebral contusion).

Forty-six patients (42.6%) had associated intracranial lesions. These included cerebral contusions underlying the embracing fracture in 26.8% (29 cases) Figure 1C, 1D, 2G; acute subdural hematoma 1.8% (2 cases) and one case of

extradural hematoma 0.9%. Traumatic meningeal hemorrhage accounted for 15.7% (17 cases).



**Figure 4:** right frontal depressed skull fracture.  
**E:** 3D reconstruction, bone window.  
**F:** Axial section, bone window.  
**G:** Axial section, parenchymal window (frontal contusion under the fracture).

### Treatment

Drug treatment consisted of the use of level I analgesics in 12 patients (11.1%), level II in 3 patients (2.8%), and a combination of levels I and II in 93 patients (86.1% of cases). An anti-inflammatory agent was combined with this treatment in 87 patients (85.6%). Bi-antibiotic therapy lasting 10 to 14 days was initiated in 58.3% (63 cases). Mannitol® osmotherapy was used in 5 patients (4.6%). In 49% of cases, surgery was performed through a single trepan hole. A craniotomy with repositioning of the bone flap was performed in 34.3%. Craniotomy and repositioning of bone fragments was performed in 17 patients (15.7%). A lost bone craniectomy was performed on one patient. This surgery was associated with scalp wound trimming in 58.3% of cases. Details of the surgery are given in Table 3. Physiotherapy rehabilitation was carried out in 51 patients (47.2%).

At one month's follow-up, seven patients had been lost to follow-up (6.5%). Progress was favorable in 70 patients (69.3%), of whom 49 had returned to normal activities, and 21 had minor problems such as intermittent headaches and/or vertigo. The motor deficit persisted in 24 patients

**Table 3:** Pathologies and surgical techniques.

Diagnosis	Techniques	Number	Frequency
Open depressed skull fracture	- lifting the skull deformity through a simple drill hole	53	49%
Depressed skull fracture with	- scalp wound trimming		
	- Craniotomy flap with fracture reduction	35 cas	
Depressed skull fracture with	- hematoma evacuation	3 cas	34.3%
	- bone flap repair	2 cas	
Comminuted depressed skull fracture	-wound trimming	9 cas	
	- craniotomy with repositioning of bone fragments	17	15.7%
Comminuted depressed skull fracture	- craniotomy with repositioning of bone fragments and wound trimming	8 cas	
	Lost-bone craniectomy	1	0,9%

(23.8%). Three patients presented with a surgical site infection (2.9%). Four patients were on anti-epileptic drugs (3.9%). Mortality was nil. At 6 months, 11 patients were lost to follow-up. Clinical outcome was good in 77.3% of patients (75 cases). Sixteen patients continued with motor rehabilitation due to persistent neurological deficits (16.5%). Three patients were still on anti-epileptic drugs (3.1%). Two patients died (2.06%), one from status epilepticus and the other from head trauma.

## DISCUSSION

Head injuries are a major problem in both developed and developing countries.<sup>3</sup> In French-speaking black Africa, the frequency of depressed skull fractures ranges from 4.3%<sup>4</sup> to 17.5%.<sup>5</sup> In our series, it was 16%. These countries share more or less the same lifestyles, with motorcycles as the main means of transport. This makes road traffic accidents the leading cause of head injury in these countries, with a high risk of embracing fractures. According to Molla and Alemu, depressed skull fractures account for up to 6% of all head injuries, and 11% of severe head injuries.<sup>3</sup> The average age of patients in our cohort was 27 years; 19.15 years in the Sambou study in Senegal.<sup>4</sup> Depressed skull

fractures due to head trauma are more common in younger subjects.<sup>3;6;7;8</sup> Youth is that period of carelessness and sometimes recklessness that can lead to risk-taking ending in head injury. The predominance of males in our study has been reported in the literature in series from Africa,<sup>5;9</sup> the Middle East<sup>10</sup>, and Asia<sup>11;12</sup> and in other works in the literature,<sup>3;6;7;8</sup> with varying frequencies. In their daily activities, men are more inclined to take risks that could expose them to head trauma. This behavior may be hormonally driven by testosterone.

Contrary to some authors who reported a predominance of pupils and students,<sup>4;5</sup> apprentice motorcycle repairers were the most affected in our study. People with a low level of education, notably motorcycle repair apprentices, manual workers, and dealers, accounted for 45.4% of our cohort. Most of these people were ignorant of or disrespectful of, the rules of the road. This makes road accidents the leading cause of head trauma leading to fractured bones.<sup>4</sup> Social violence, intercommunity conflicts and lack of protection at work explain the high frequency of assaults and falls from height in our study. In a study carried out in Ethiopia, assaults and injuries accounted for 62.5% of cases,<sup>6</sup> as in the series by Molla and al, with 62.5% of cases of physical

aggression involving blows and wounds.<sup>6</sup> In other studies, road traffic accidents were the main mechanism of head injury.<sup>3;7;13</sup>

Headache is a predominant symptom of traumatic deformity skull fracture, either localized to the fracture zone or diffuse and accentuated by palpation. It may be associated with neurological disorders such as altered consciousness or focal neurological deficits. The 64.7% of skull-depressed fractures with an adjacent scalp wound recorded in our series reflect the violence of the cranial trauma. Headache may be preceded by an initial loss of consciousness, suggesting concussion. It was reported in 77.1% of patients in the series by Sambou and al.<sup>4</sup> The initial loss of consciousness followed by headache and vomiting as signs of intracranial hypertension were reported in the cohort of Molla et al.<sup>3</sup> In addition to intracranial hypertension, depression skull fracture may manifest as epileptic seizures.<sup>8</sup> They may appear immediately after the trauma or appear later.<sup>8</sup> In depressed skull fractures, seizures appear later rather than earlier.<sup>8</sup> Because of its cost, availability, and shorter acquisition time, a cerebral CT scan is the examination's first choice in craniocerebral traumatology.<sup>14</sup> It is highly effective in diagnosing neurotraumatic craniocerebral pathologies. In our series, we were able to determine the parietal and frontal locations of fractures. The predilection for these locations reported by several authors<sup>3,4;6,9,12</sup> could be explained by the prominent nature of these bones, which are also devoid of muscular protection. "Ping-Pong ball" fractures were encountered in children in our study. As ossification is not complete in children, their skulls are malleable, making them deformable. This is not the case in adults, where the embracing fracture takes the form of a "stair step", with rupture of the two tables and the diploe. As in the series by Molla and al.<sup>6</sup>, cerebral contusion was the most frequently associated intracranial lesion in our study. In other studies, this was extradural hematoma<sup>3;9</sup>, which constitutes a neurosurgical emergency pathology.

The management of embracing fractures requires a multidisciplinary approach.<sup>6</sup> Some depressed skull fractures can be treated without surgery (conservative treatment).<sup>8</sup> The use of antibiotics outside the operating theatre and the use of antiepileptic drugs as a preventive measure are controversial issues. For example, a study by Suliman and al examined the views of 218 practitioners from 56 countries on variations in the neurosurgical management of depressed skull fractures in adults; most respondents (79.4%) had offered prophylactic antibiotic therapy to all patients with open fractures, and less than half (48.2%) had offered prophylactic anti-epileptic treatment; on the other hand, for closed depressed skull fractures, most European respondents (81.7%) did not suggest prophylactic antiepileptics.<sup>15</sup> Our patients with a scalp wound opposite the bill were treated with antibiotics. This would allow the focus to be dug out to prevent bacterial infection.

Fractures with a depression of 5 mm or more should be considered for surgery. Other factors to be taken into account in the operative decision may be the presence of a wound opposite the fracture,<sup>15</sup> the existence of associated intracranial lesions, and the patient's neurological condition. The surgical indication in the Suliman and al cohort was based on the presence of a grossly contaminated wound, the opening of dura mater, significant skull depression, and the existence of contusion and/or an underlying hematoma with mass effect.<sup>15</sup> Careful exploration and trimming of the wound must precede the removal of the depressed bone. This can be done through a trepan hole or, if necessary, by a craniotomy with bone flap replacement, or even a lost-bone craniectomy. Craniotomy with replacement of the bone fragment was the most common technique used (43.8%) by Assoumane et al, followed by simple elevation of the depressed skull fracture in 42.5% of cases.<sup>13</sup> Complications may arise after surgery. These may include infection of the surgical site, meningitis, and brain abscesses.<sup>6</sup>

Mortality and morbidity are a function of intracranial lesions, extra-cranial solid organs, and limb lesions. Early and appropriate treatment can optimize outcomes. A zero mortality rate has been found in some studies in Africa.<sup>4,16</sup> It was 0.9% in Niger,<sup>13</sup> 16.77% in the study by Prakash et al, in India<sup>7</sup>, and 2% in ours, with morbidity of 19.6%. Molla and al found that 9% of sequelae were related to cerebral lesions below the fracture. These were mainly hemiparesis and aphasia.<sup>6</sup> These authors had reported that factors associated with poorer outcomes included an open depressed skull fracture, a low Glasgow score on patient admission, the presence of hemiparesis, and the presence of an extradural hematoma.<sup>6</sup> Healing without sequelae can be achieved in up to 91% of cases or even more. These rates could improve with the development of pre-hospital medicine and the upgrading of technical facilities in our countries.

## CONCLUSION

Fractures of the cranial vault are frequently encountered in trauma. This condition, which is most often treated as a minor problem, can sometimes lead to significant neurological sequelae. We need to think beyond the aesthetic aspect, to provide early and appropriate treatment, with the hope of achieving better results.

## LIMITATIONS

The sample size is somewhat small. This study focused only on operated depressed skull fractures. The sample size would have been very large if all cases of depressed skull fractures (operated or not) had been included.

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**Additional Information**

**Disclosures:** Authors report no conflict of interest.

**Ethical Review Board Approval:** The study conformed to the ethical review board requirements. The data was included with patient(s) consent.

**Conflicts of Interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following.

**Financial Relationships:** All authors declare that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.

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**Data Availability:** Data will be made available upon an adequate request by the principal Moussa Diallo (e-mail:mdiallo5@gmail.com)

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**AUTHORS CONTRIBUTIONS**

Author’s Full Name	Intellectual Contribution to Paper in Terms of
Moussa Diallo	Study design, methodology, and paper writing.
Drissa Kanikomo	Analysis of data and interpretation of results.
Youssouf Traoré	Literature review and referencing.
Agnès Mbingtong Ndam	Data collection and calculations.
Youssouf Sogoba	Literature review and referencing.
Izoudine Blaise Koumaré & Oumar Diallo	Editing and quality insurer.