Med. J. Cairo Univ., Vol. 87, No. 3, June: 1917-1925, 2019
www.medicaljournalofcairouniversity.net

Surgical Elevation for Symptomatic Depressed Skull Fractures Over Dural Venous Sinus

AMR F. KHALIL, M.D., Ph.D. and HESHAM EL-SOBKEY, M.D., Ph.D.

The Department of Neurosurgery, Faculty of Medicine, Mansoura University

Abstract

Background: Symptomatic depressed skull fractures over dural venous sinus occasionally lead to stenosis, obstruction, or thrombosis and resulting in intracranial hypertension and significant neurological deficit. Some neurosurgeons are treating these cases conservatively for fear of venous hemorrhage. The surgical elevation of the depressed segment in these cases is a matter of controversy and these patients should be treated carefully.

Aim of Study: The aim of this retrospective study was to evaluate outcome after surgical elevation of symptomatic depressed skull bone fracture over dural venous sinus.

Patients and Methods: A retrospective study of symptomatic depressed calvarial fractures presented at Mansoura University Hospital from 2015 to 2018 revealed 11 patients with depressed skull fractures over superior sagittal sinus (n=6) and transverse sinus (n=5). The age ranged from 11-31 years. The causes of these fractures were vehicle accidents and falling from height. Significant neurological deterioration ranged from blurring of vision and motor weakness. MR venography was done in stable and late symptomatic cases to assess sinus patency.

Results: Surgical elevation was performed in 10 patients suffered from depressed skull fracture over large venous sinus and conservative treatment for one patient at the transverse sinus and the patient shows patent sinus on MRV and clinically well. Rapid resolution of symptoms and signs as well as sinus patency after elevation.

Conclusion: Although the risk of sinus injury during surgical elevation of the depressed segment but it is recommended to perform surgery for these symptomatic patients with all precautions required like blood transfusion and preparing vascular graft form the pericranium for sinus repair and this leads to rapid resolution of symptoms and signs as well as sinus patency improvement after elevation.

Key Words: *Depresses skull fracture – Venous sinus – Surgical elevation.*

Correspondence to: Dr. Amr F. Khalil, The Department of Neurosurgery, Faculty of Medicine, Mansoura University

Introduction

TRAUMA involving areas of the skull related to the venous sinuses is of crucial importance as it does not only lead to hemorrhage at the time of trauma, but also massive hemorrhage can be encountered by the neurosurgeon during surgical repair leading to increased risk of mortality. It was reported in the literature that injury to the dural venous sinuses occupies about 1-4% of all craniocerebral traumatic injuries in civilian life [1,2].

Skull fractures have many types; linear, depressed, and comminuted. A depressed fracture is diagnosed when the affected bony fragments are pushed inwards by the traumatic agent and it is one of the most neurosurgical conditions requiring emergency surgical procedure [3]. Open depressed skull fractures which are located closely to a dural venous sinus is considered life threatening because of the risk of hemorrhage it carries at presentation or at the time of intervention as discussed before [4].

It has been reported that massive blood transfusion during dural sinus surgeries may lead to some sort of bleeding diathesis during or after surgery. Behera and his colleagues published that thrombocytopenia was present in 85%, and defibrination occurred in 69% of cases diagnosed with dural sinus injury and consequently, it is heavily recommended to monitor the coagulation profile of the patient during the surgical procedure, especially if blood transfusion was commenced [5].

Additionally, Venous Air Embolism (VAE) has been also reported in such operations. In fact, VAE can complicate any neurosurgical procedure but sitting and semisitting position during operation carry a high risk for this complication to happen. The diagnosis and treatment of such condition are

carried out primarily by the neuroanesthesiologist [6].

The anterior and middle thirds of the superior sagittal sinus are considered the commonest areas to be affected. Meier et al., [7] Meirowsky, [8] Kapp and Gielchinsky, [9] and Kapp et al., [10] have published that the incidence of dural sinus injury in the previously discussed locations were 66%, 57%, 74%, and 82% in order of speech. Locating the precise location of the affected sinus is very important factor in determining patient morbidity and mortality. It has been reported that injuries involving the superior sagittal sinus is associated with better prognosis as has an adequate collateral pathways that helps the patient to better tolerate either sinus injury or ligation [1].

This close proximity of these depressed fractures to the venous sinuses makes surgical intervention potentially hazardous. Multiple studies have reported that the incidence of bleeding encountered during surgeries for depressed fracture located over venous sinuses may reach about 23%-20% of cases [2,11].

Miller and Jennett reported that the incidence of depressed fractures penetrating into an underlying venous sinus may reach 11.5%. Moreover, they recommended to use the conservative approach for managing such cases to avoid hemorrhage that may complicate surgery [11].

On the other hand, the open type of depressed fractures requires surgical intervention as early as possible as dural defect repair is essential to prevent subsequent infectious complications. However, there have been some recommendation to perform surgery in closed depressed fractures under specific situations like evacuation of hematoma, repair of dural laceration, or correction of cosmetic deformity [12]. In addition, some neurosurgical textbooks rarely see that depressed skull fracture involving a venous sinus is an indication for surgical intervention [1].

As many surgeons may be cautious to perform surgery for these fractures, the application of conservative treatment should be weighed against the future complications that may be faced with conservation like hematoma formation, infection, mass effect, and cosmetic disfigurement [2].

Despite the previous fears discussed earlier about hemorrhage that may face surgeon during operation for such traumatic lesions, other authors stated that surgical treatment by craniectomy and elevated depressed bone is a rapid and effective method with little risk of severe haemorrhage. Moreover, such operations often have good prognosis with rapid return of ICP to its normal values, regression of the neurological deficits, and restoration of dural sinus continuity as detected by postoperative imaging studies [13].

Patients and Methods

Study design:

A retrospective study of symptomatic depressed calvarial fractures presented at Mansoura University Hospital from 2015 to 2018.

Patient sample:

Eleven patients with depressed skull fractures over superior sagittal sinus (n=6) and transverse sinus (n=5) were diagnosed and included in our study.

Patient consent:

A written formal consent was obtained from patients or relatives in unconscious patients after the explanation of the details, advantages and drawbacks of the surgical procedure.

Patient preparation:

At the time of admission, careful history about the mode of injury, and through neurological examination were performed for every patient, including Glasgow Coma Scale (GCS). Plain X-ray and Computed Tomography (CT) were performed for exact localization of the site and extension of the fracture. Moreover, associated intracranial lesions were also searched for on CT films. MR venography was done pre-operatively if stable neurological condition to assess sinus patency Figs. (1,2).

Management plan:

All cases were surgically treated immediately upon admission (craniotomy and surgical elevation) as shown in Fig. (6), except one patient who came after 2 months and another patient who was treated conservatively as this patient had no neurological deficits and his transverse sinus was patent on performing MRV. Measures against venous air embolism were followed during the procedure.

We used definitions reported in the study conducted by and kim and his colleagues. When the encountered dural bleeding could be stopped by simple digital compression via gel foam, it was classified as simple bleeding. On the other hand, if it could not be stopped by that way, bleeding was classified to be difficult [1].

Data collection

Patient demographics, clinical data, operative details including blood loss and transfusion, post-operative recovery including resolution of the pre-existing neurological deficit and restoration of the dural sinus continuity were noted.

Results

Patient demographics:

All the included cases were males (n=11) with median age of 23 years (range 11-3 1). These data are illustrated in (Table 1).

Etiology:

The majority of our cases (10 cases-90.9%) were caused by Road Traffic Accidents (RTA), while only one case was caused by Falling From Height (FFH).

Clinical presentation:

Eight patients had a GCS of 12-15/15 while only one case presented with quadriparesis. One case presented with paraplegia and had associated lumbar spine fracture and brain contusion. Two patients presented with intra cranial hemorrhage (epidural hemorrhage, the other left temporal intracerebral hematoma). The remaining case presented with delayed raised ICP (6 th nerve palsy and papilledema) as he had head trauma 2 months earlier.

Fracture site and type:

The superior sagittal sinus was commonly affected when compared to the transverse sinus (6 cases Vs. 5 cases). All cases had a depressed compound fracture except two, who had the simple type.

Management:

Ten patients were taken to the operating theatre for craniectomy and dural closure under general anesthesia. All bone fragments were removed and the dural laceration was patched with pericranium without manipulation on cerebral prolapse if present. Intraoperative haemorrhage was controlled by means of local hemostatics, digital pressure, elevation of the head and muscle graft sutures.

Operative difficulties were manifested mainly as intraoperative sinus bleeding that was encountered in 4 cases who underwent surgery (40%). Consequently, intraoperative blood transfusion was required in these cases. Venous air embolism occurred in one case (10% of the surgical cases).

Regarding the case who was treated conservatively, cleaning and washing of the overlying wound were carried out by the neurosurgical specialist under local anesthesia (Case 9).

Outcome:

Superficial surgical site infection was detected in one case who underwent surgery (9.09%), while intradural abscess and subdural empyema was not reported in our study.

Rapid resolution of symptoms and signs as well as sinus patency was restored after surgical elevation apart from the paraplegia in the patient who had lumbar spine fracture.

Table (1): Summary of the study data.

Case No.	Age/Y	Sex	Type of trauma	Site of sinus injury	Neurological condition/ GCS pre-op.	Simple/ Compound	Associated injury	Complications
• Case 1	• 31	• M	• RTA	• SSS/Post.1/3	• 6th N Palsy/ Papilledema	• Simple	• Delayed raised ICP	• Hemorrhage
• Case 2	• 25	• M	• RTA	• SSS/Antt.1/3	• Quadriparesis	• Compound	• Epidural heamatoma	• Hemorrhage
• Case 3	• 12	• M	• RTA	• SSS/Antt.1/3	• Paraplegic	• Compound	• Lumber spine fracture/brain contusion	• Venous air embolism
• Case 4	• 28	• M	• RTA	• SSS/Post.1/3	• 14	• Compound		• Hemorrhage
• Case 5	• 30	• M	• RTA	• SSS/Middle1/3	• 12	• Compound		
• Case 6	• 19	• M	• RTA	• SSS/Antt.1/3	• 14	• Compound		• Hemorrhage
• Case 7	• 23	• M	• RTA	• Transverse sinus/Rt	• 13	• Compound	• Small ICH (intracerebral hemorrhage)	
• Case 8	• 30	• M	• RTA	• Transverse sinus/Rt	• 14	• Compound		• Superficial wound infection
• Case 9	• 12	• M	• RTA	• Transverse sinus/Rt	• 14	• Compound		
• Case 10	• 19	• M	• RTA	• Transverse sinus/Rt	• 15	• Compound		• Conservative
• Case 11	• 11	• M	• FFH	• Transverse sinus/Rt	• 15	• Simple		

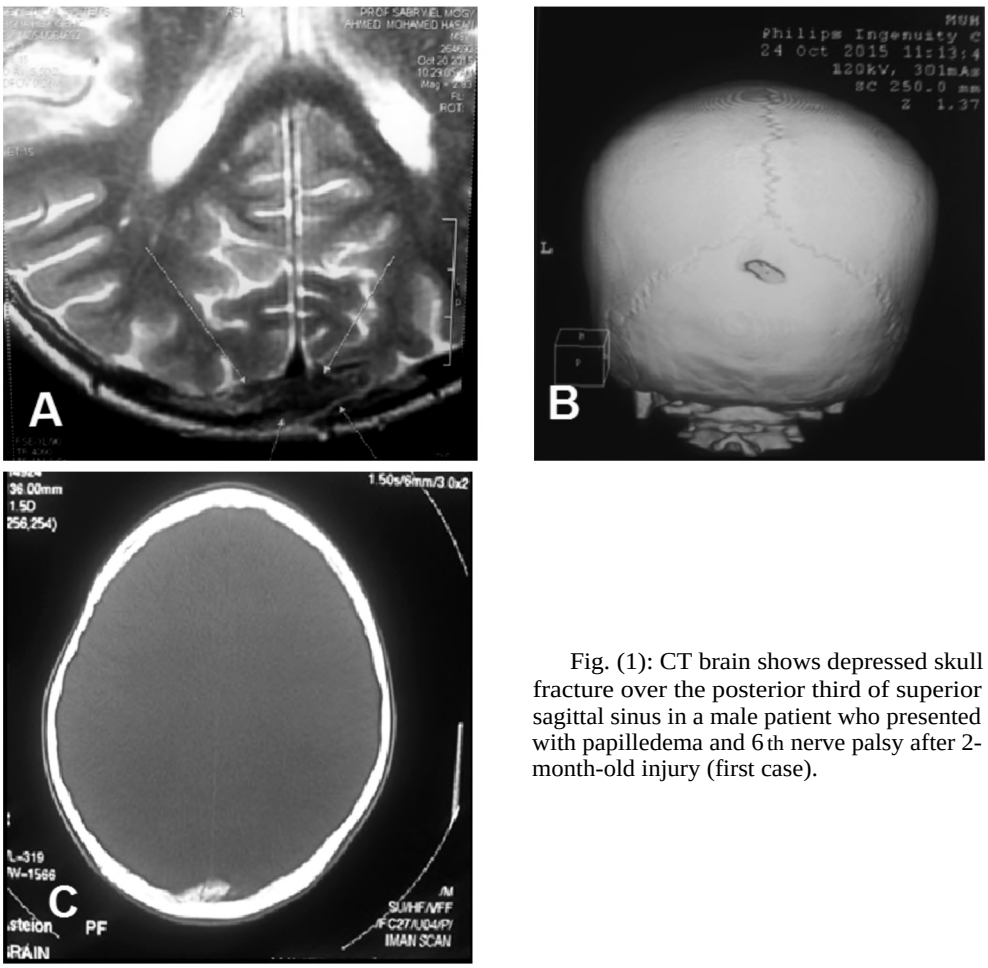

Fig. (1): CT brain shows depressed skull fracture over the posterior third of superior sagittal sinus in a male patient who presented with papilledema and 6th nerve palsy after 2-month-old injury (first case).

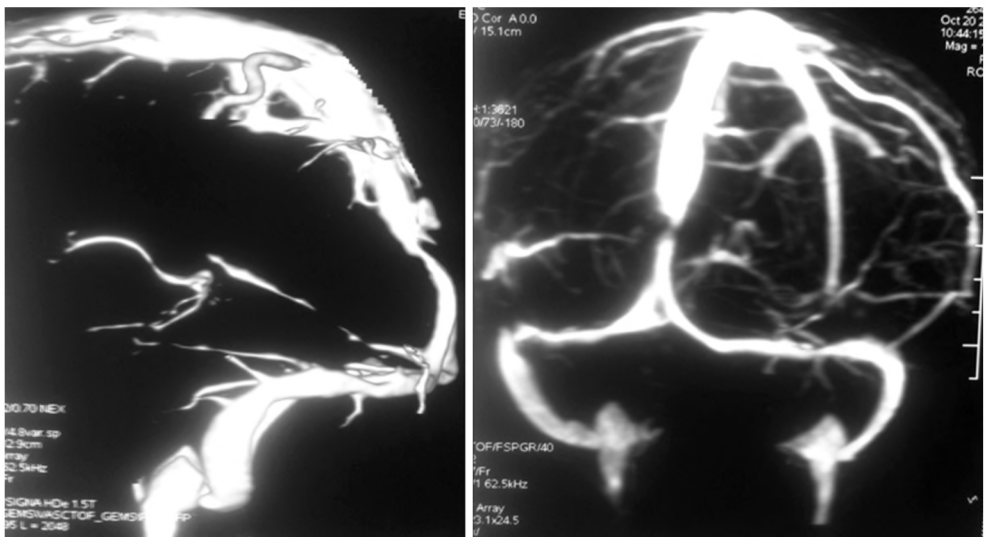

Fig. (2): MRV pre-operative shows superior sagittal sinus occlusion (first case).

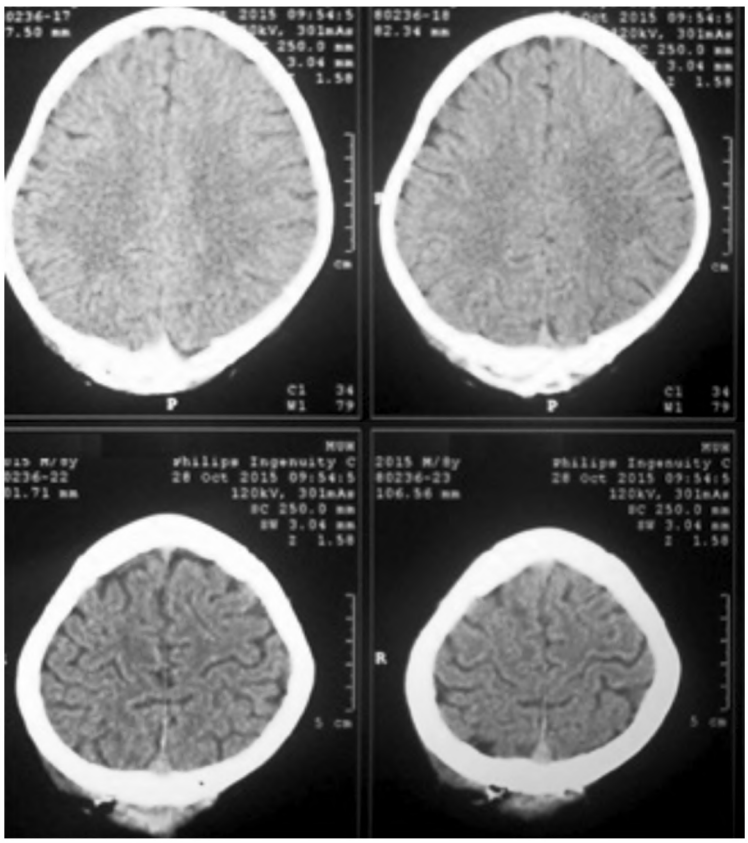

Fig. (3): Post-operative CT brain after bone elevation of the same case (first case).

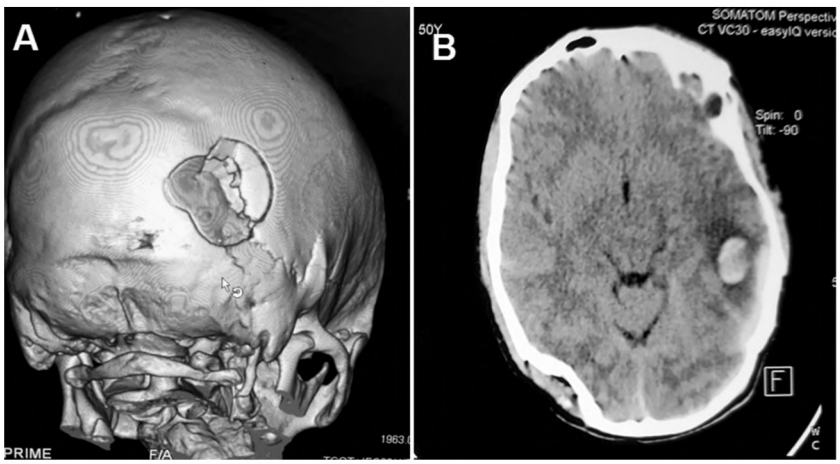

Fig. (4): Pre-operative CT brain shows depressed fracture over the right transverse sinus. (A) 3D CT skull shows depressed left occibital bone, (B) Axial CT brain shows right occipital fracture and left temporal intracerebral hemorrhage (case 7).

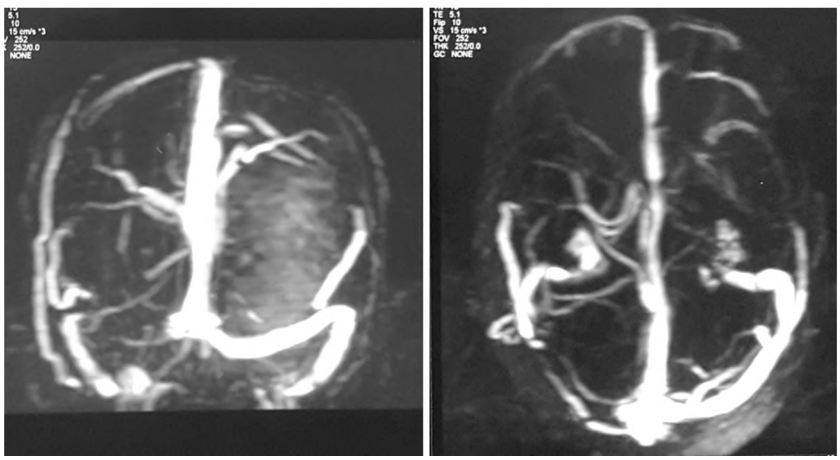

Fig. (5): Pre-operative MRV transverse sinus occlusion at the (Case 7).

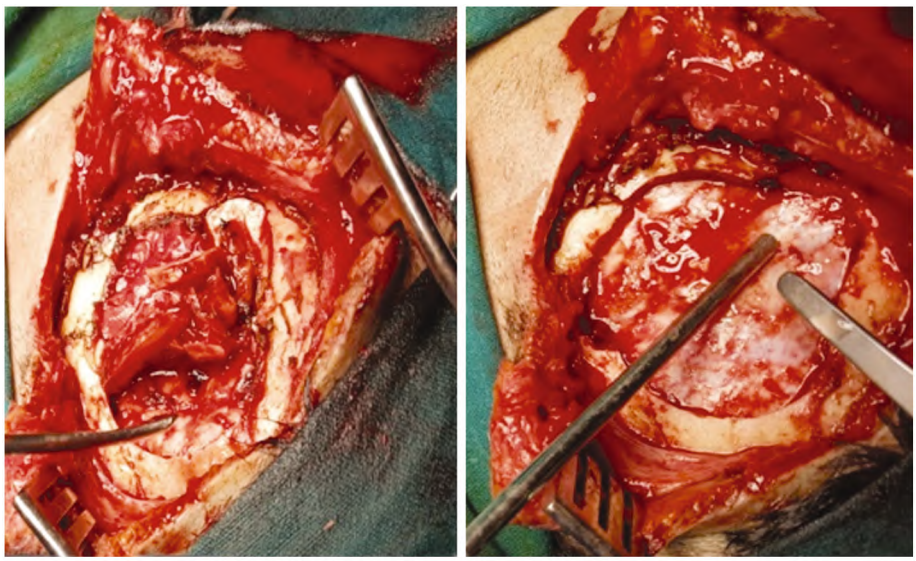

Fig. (6): Bone elevation over the stenotic transvers sinus at the same case (Case 7).

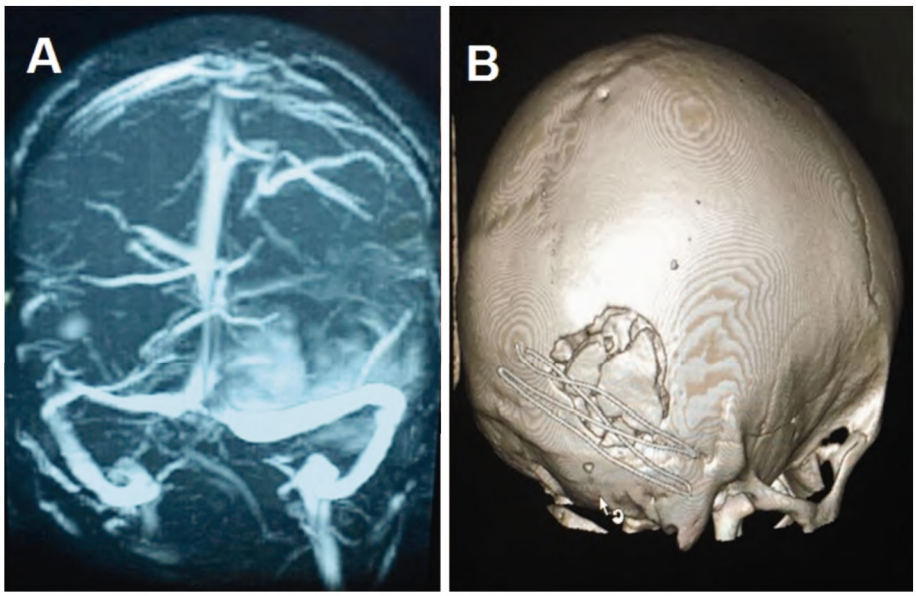

Fig. (7): (A) MRV showing transverse sinus patency post-operatively. (B) CT (3D) skull shows bone reconstruction (Case 7).

Fig. (8): Sagittal CT lumbosacral spine with reconstruction showing lumbar spine burst fracture in the paraplegic Case (3) (associated pathology).

Discussion

Between various types of craniocerebral injuries, dural sinus injuries constitutes 4-12% of these injuries at the time of war, and about 1-4% in the civilian life. The profuse bleeding that may result from dural sinus wall laceration, caused by these fractures, makes these traumatic lesions very important in clinical neurosurgical practice [1].

There are two reported ways to deal with such lesions; conservation or surgical intervention. Surgery involves elevation of the depressed bone, exploration, and debridement of the devitalized tissues. These steps will help to decrease infectious complications and improve the cosmetic outcome. However, mortality associated with surgical intervention has been reported to reach about 10% [9].

The native concept of mandatory surgical intervention for such lesion was first opposed by Van der Heever and Van der Merwe when they noted that patients treated via the conservative approach had a comparable results compared with cases treated surgically **[14]**.

In this study, we included 11 cases with depressed fractures overlying brain venous sinuses, with median age of 23 years (range 11-31 years) to evaluate the safety and feasibility of surgical intervention in such cases. Moreover, all our study cases were males (100%). Six cases (54.54%) had a fracture overlying the superior sagittal sinus, while the remaining five cases (45.45%) had a fracture overlying the transverse sinus.

Another study included 17 cases with depressed fractures overlying venous sinuses. Fifteen males and two females were included. Their ages had a mean of 24.2 years (range 7-48 years). The reported cause of injury was road traffic accident (8 cases-47.05%), assault (6 cases-35.29%), fall (2 cases 11.76%), and struck by a falling object (1 case-5.88%). The most commonly involved sinus was the middle third of the superior sagittal sinus while the majority of cases had mild neurological deficits **[4]**.

The most common form of head trauma experienced by our patients was road traffic accidents (10 cases), while only one case had a history of falling from height.

Another study handling the same perspective included 27 cases from whom 3 cases were females (11.11%). Their age ranged from 20 to 89 years and the majority of these cases (96.2%) were caused by assaults. Like our study, the superior sagittal sinus was the commonest affected dural sinus. Regarding presentation, the majority of these cases had a GCS of 14-15/15 while three cases had a GCS lower than 13. Only two cases at that study experienced focal neurological deficits at the time of examination **[2]**.

In our study, the majority of cases had a GCS of 12-15/15, while quadriplegia and paraplegia were diagnosed only in one case for each.

Intracranial hypertension secondary to depressed skull fracture occluding the sagittal sinus has been described **[15]**. In our study, one case who experienced 2-month-old head trauma experienced delayed rise in the intracranial pressure.

Headache, nausea, vomiting, or papilledema are various manifestations of increased intracranial pressure that may manifest early or late (may reach several weeks) after head trauma. The presence of elevated ICP is an indication for surgical intervention and elevation of that depressed bone as recommended by many neurosurgeons even if there is a risk of intraoperative hemorrhage **[13]**.

In our study, ten cases (90.9%) were managed surgically, while the remaining case were managed conservatively. That patient was stable on neurological examination and his MRV showed that there was no transverse sinus obliteration.

Özer and his associates performed all surgeries within 24 hours of trauma **[4]**, while one case in our study has presented after 2 months of injury.

On the other hand, the study conducted by LeFeuvre and his associates managed 14 cases (51.85%) conservatively, while 13 cases (48.14%) were managed surgically. Regarding surgical complications experienced in these 13 cases, difficult operation was reported in 6 cases (46%), while massive intraoperative bleeding was encountered in 3 cases (23%). Additionally, superficial wound infection was diagnosed in two cases (15.38%) **[2]**.

In our study, operative difficulties were manifested mainly as intraoperative sinus bleeding that was encountered in 4 cases who underwent surgery (40%). Consequently, intraoperative blood transfusion was required in these cases.

There are multiple techniques that have been discussed in the literature to deal with such dutral hemorrhage to decrease the ongoing blood loss; the simplest of which is digital pressure with gelfoam, dura, pericranium, temporal fascia or muscle **[16,17]**. Additionally, simple suturing of the injured dural walls allowing closure, hitching of the dura to the bone adjacent to the sinus, rostral part ligation or clipping, transplantation with an autologuos vein, artificial sinus prosthesis, balloon catheter, and T-drainage also have been described **[7,18]**.

Intraoperative sinus bleeding was encountered more frequently in the study performed by Özer et al., as they experienced hemorrhage in 13 cases (76.47%) who required blood transfusion. Only four cases in their study did not require transfusion **[4]**.

Another complication to be considered during surgery is venous air embolism. The management of such problem requires stoppage of air entry into the patient circulation. Maintaining patient hydration (monitored by central venous pressure and

systolic volume) before and during the surgical procedure helps to reduce the pressure gradient between the right atrium and venous port of entry, leading to decrease in the incidence of that hazardous complication [6].

Upon suspicion of venous air embolism, the anesthesiologist must order the surgeon to merge the surgical field with fluid to cover the venous port of entry. Also, anesthesiologist should increase O_2 delivered to the patient up to 100% as nitric oxide (NO) and oxygen/air mixtures are avoided [19].

After that, the patient should be positioned at the left lateral decubitus as that will help air emboli to go to the right atrium. The presence of a central venous catheter inserted into the patient will help the anesthesiologist to aspirate any air trapped between the superior vena cava and right atrium [20]. In a dog trial having a right atrium catheter available allowed for aspiration of up to 50% of the emboli air volume [21].

All the previous recommendations have been followed by our surgical team during performing these procedures. One case has experienced venous air embolism during operation in this study (10% of the surgical cases).

It is our policy at Mansoura University Hospitals to give IV antibiotics to patients with compound depressed skull fractures for 48 hours to decrease the incidence of wound sepsis.

Superficial surgical site infection was detected only in one case in our study (10% of surgical cases). It is possible that infection was the result of residual wound contamination or may have been caused by the liberal use of hemostatic agents and remaining blood clot. On the other hand, intradural abscess, subdural empyema, and mortality was not reported in our study.

Another study did not prefer to give IV antibiotics for patients who sustained their injuries through blunt assault, and it was felt these wounds were clean [2].

An important factor that should be kept in mind as it contributes to mortality is the presence of associated parenchymatous intracranial lesions. Mortality rates have been reported to increase 3 to 5 folds in such traumatic fractures when combined with brain stem lesions [7,10]. We have experienced one case with Epidural hematoma that was surgically evacuated and two other cases with brain contusions that managed conservatively.

Miller and Janett, in their research that included 400 patients, experienced extreme operating difficulties in 9 of their 46 patients (20%) who had sinus involvement and managed surgically and IV transfusion of up to 4 units of blood was required in such situations [11].

One study showed that these fractures overlying dural sinuses did not cause dural wall injury in 35% of the included cases. Moreover, simple digital pressure was sufficient to stop hemorrhage originating from the lacerated sinus walls in all cases. No operative mortality was experienced in that study. Pre-operative preparation of these patient os of crucial importance. Consequently, if the patient had a stable condition, proper and wise evaluation via radiological angiography like MRV may be helpful for operative planning [4].

After surgery, rapid resolution of symptoms and signs as well as sinus patency was restored after surgical elevation apart from the paraplegia in the patient who had lumbar spine fracture.

Conclusion:

Although the risk of sinus injury during surgical elevation of the depressed segment but with expert surgeon it is recommend to perform surgery for these symptomatic patients with all precautions required like blood transfusion and preparing vascular graft form the pericranium for sinus repair and this leads to rapid resolution of symptoms and signs as well as sinus patency improvement after elevation. With conservative treatment for depressed fracture over venous sinus elevated intracranial pressure secondary to compression on the posterior part of the Superior Sagittal Sinus (SSS) may account for clinical deterioration.

References

1- KIM Y.S., JUNG S.H., LIM D.H., KIM T.S., KIM J.H., and LEE J.K.: Traumatic dural venous sinus injury. Korean Journal of Neurotrauma, 11 (2): 118-23, 2015.

2- LEFEUVRE D., TAYLOR A. and PETER J.C.: Compound depressed skull fractures involving a venous sinus. Surgical Neurology, 62 (2): 121-5, 2004.

3- SENDJAJA A., SUTIONO A., FARIED A. and ARIFIN M.: Open depressed and compound elevated skull fracture over the superior sagittal sinus: A case report. J. Surg., 2968 (001): 2016.

4- ÖZER F.D., YURT A., SUCU H.K. and TEKTAŞ Ş.: Depressed fractures over cranial venous sinus. The Journal of Emergency Medicine, 29 (2): 137-9, 2005.

5- BEHERA S.K., SENAPATI S.B., MISHRA S.S. and DAS S.: Management of superior sagittal sinus injury encountered in traumatic head injury patients: Analysis of 15 cases. Asian Journal of Neurosurgery, 10 (1): 17, 2015.

6- GIRALDO M., LOPERA L.M. and ARANGO M.: Venous air embolism in neurosurgery. Revista Colombiana de Anestesiología, 43: 40-4, 2015.

7- MEIER U., GÄRTNER F., KNOPF W., KLÖTZER R., and WOLF O.: The traumatic dural sinus injury-a clinical study. Acta Neurochirurgica, 119 (1-4): 91-3, 1992.

8- MEIROWSKY A.M.: Wounds of dural sinuses. Journal of neurosurgery, 10 (5): 496-514, 1953.

9- KAPP J.: Management of combat wounds of the dural venous sinuses. Surg., 71: 913-7, 1972.

10- KAPP J., GIELCHINSKY I. and DEARDOURFF S.L.: Operative techniques for management of lesions involving the dural venous sinuses. Surgical Neurology, 7 (6): 339-42, 1977.

11- MILLER J. and JENNETT W.B.: Complications of depressed skull fracture. The Lancet, 292 (7576): 991-5, 1968.

12- STEINBOK P., FLODMARK O., MARTENS D. and GERMANN E.T.: Management of simple depressed skull fractures in children. Journal of Neurosurgery, 66 (4): 506-10, 1987.

13- SAN JUAN G.Z., MÍGUEZ A.V., CENOZ I.Z., ORTEGA A.C., CAMPOS M.G., De FRUTOS MARCOS D. and ROMERO J.C.G.: Intracranial hypertension caused by superior sagittal sinus stenosis secondary to a depressed skull fracture: Case report and review of the literature. Neurocirugía: 2018.

14- VAN DEN HEEVER C.M. and VAN DER MERWE D.J.: Management of depressed skull fractures: Selective conservative management of nonmissile injuries. Journal of neurosurgery, 71 (2): 186-90, 1989.

15- UZAN M., ÇIPLAK N., DASHTI S.R., BOZKUS H., ERDINÇLER P. and AKMAN C.: Depressed skull fracture overlying the superior sagittal sinus as a cause of benign intracranial hypertension: Case report. Journal of Neurosurgery, 88 (3): 598-600, 1998.

16- VALADKA A. and NARAYAN R.: Surgical aspects of the head injured. Neurotrauma. New York: McGraw-HIII Book Comp: 203-24, 1996.

17- GEISLER F.: Skull fractures. Neurosurgery, 2: 2741-54, 1996.

18- KELLY D., NIKAS D. and BECKER D.P.: Diagnosis and treatment of moderate and severe head injuries in adults. Neurological Surgery, 3: 1618-718, 1997.

19- PASTERNAK J.J. and LANIER W.L.: Is nitrous oxide use appropriate in neurosurgical and neurologically at-risk patients? Current Opinion in Anesthesiology, 23 (5): 544-50, 2010.

20- ARAGONÉS MANZANARES R., CABELLO ROIG B., MEDINA ARTEAGA A., MUÑOZ LOPEZ A., SELLER PÉREZ G. and DELGADO AMAYA M.: Edema pulmonar agudo tras embolismo aéreo venoso central. Medicina intensiva, 26 (3): 127-31, 2002.

21- SMART J. and FROST E.: Pathophysiology of 1ntrarenous Air Embolism in Dogs. Anesthesiology, 49: 120-7, 1978.

الرفع الجراحى لكسر الجمجمة المنخفض العرضى على الجيوب الوريدية السحائية

تؤدى كسور الجمجمة العرضية على الجيوب الوريدية السحائية إلى تضيق أو آنسداد أو تخثر وتؤدى إلى إرتفاع ضغط الدم داخل المخ وتدهور عصبى كبير. ويلاحظ أن بعض الجراحين الذين يعالجون هذه الحالات بشكل متحفظ خوفاً من النزيف الوريدى. يعد الإرتفاع الجراحى للجزء المنخفض فى هذه الحالات مثار جدل ويجب علاج هؤلاء المرضى بعناية. وهذه الدراسة بأثر رجعى لتقييم التدخل الجراحى لكسر الجمجمة المنخفض العرضى على الجيوب الوريدية السحائية فى مستشفى جامعة المنصور فى الفترة من ٢٠١٥ إلى ٢٠١٨ كشفت ١١مريضاً يعانون من كسور الجمجمة المنخفض على الجيب السهمى العلوى (ن=٦) والجيوب الوريدى العريض (ن=٥). تراوحت أعمارهم بين ١١ و٣١ سنة. وكانت أسباب هذه الكسور حوادث السيارات والسقوط من الإرتفاع. تراوحت الأعراض بين التدهور العصبى الكبير من عدم وضوح الرؤية والضعف الحركى. تم إجراء الرفع الجراحى فى ١٠مرضى والعلاج التحفظى لمريض واحد. تحسنت الأعراض والعلامات سريعا وكذلك حالة الجيب الوريدى بعد الإرتفاع الجراحى للعظم المنخفض، بصرف النظر عن الشلل النصفى لدى مريض أصيب بكسر فى العمود الفقرى القطنى. على الرغم من أن خطر إصابة الجيوب الوريدية أثناء رفع الجزء المنخفض من العظم، إلا أنه يوصى بالجراحة لهؤلاء المرضى مع الأحتياطات اللازمة مثل نقل الدم وهذا يؤدى إلى حل سريع للأعراض مع منع حدوث مضاعفات عصبية.