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Revisiting the Approach to Surgical Management of Depressed Skull fracture in Children during SARS-CoV-2 Pandemic.

Boris Kangabam[1], Kh Vyas[2], Supriya Laifangbam[3], Thokchom Amataleima[1]
1. PG Trainee, Department of Surgery, Jawaharlal Nehru Institute of Medical Sciences, Porompat, Imphal, India
2. Associate professor, Neurosurgery Unit, Department of Surgery, Jawaharlal Nehru Institute of Medical Sciences, Porompat, Imphal, India
3. Professor, Department of Microbiology, Jawaharlal Nehru Institute of Medical Sciences, Porompat, Imphal, India
Corresponding author: Kh Vyas
Neurosurgery Unit, Department of Surgery, Jawaharlal Nehru Institute of Medical Sciences, Porompat, Imphal, India

Abstract:
Depressed skull fractures make up 7-10% of children admitted in hospitals with head injury.Neurosurgeons should keep abreast of the current recommendations in light of the SARS-CoV-2pandemic. Here we describe a series of cases of closed depressed skull fracture with depression greater than 1 cm in children following trauma and associated protocols for admission and surgical management in Neurosurgery Unit during the SARS-CoV-2 pandemic. Minimal intervention is the key in this pandemic so burr hole and elevation was done with excellent results.

Key words*: Depressed skull fracture, SARS-CoV-2, Closed System RT PCR*

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I. Introduction:

Head injury accounts for a majority of hospital admissions and the leading cause of neurological disability and death. The advent of SARS-CoV-2 pandemic posed a challenge for the neurosurgeon in the perioperative management, especially those of head and neck procedures where drills are used.Patients with semi-urgent neurosurgical emergency defer coming to the hospital due to fear of exposure to SARS-CoV-2.Hence,they come late and risks collateral damage.[1]Patients are admitted through the Emergency Department after thorough clinical history, physical examinationand SARS-CoV-2 testing. Depressed skull fractures (DSF) make up 7-10 % of children admitted to hospitals with a head injury[1].DSFs cancause significant complications such as post traumatic epilepsy and infection when they are associated with dural tears, penetration of the brain parenchyma by a foreign object or bone fragment, and the presence of underlying brain injury or intracranial hematoma.[2]In a growing child, early treatment is needed as it may interrupt growth and function of brain or cause epilepsy and not only for cosmetic reasons[3].Aerosol generation during surgery was kept minimal in order to reduce occupational exposure to the SARS-CoV-2 virus.

II. Methods:

In the pre-covid period, patients were admitted through the outpatient clinics and the emergency department after undergoing thorough clinical examination, routine blood tests and radiological imaging. However, during the Covid-19 era, patients are admitted only through the emergency department as OPD section are closed. Protective measures including N95 face masks, Face shields, hand sanitisers, social distancing and wearing of gloves when examining the patient are strictly adhered to. Patient attendants are also encouraged to follow the protective measures. Patients entering emergency department were triaged according to history of travel, known contact with Covid positive persons and RAT result.Suspected patients are sent to the Covidsuspect ward.

Three kinds of SARS-CoV-2 tests are available in our institute namely, the conventional open system real time Reverse Transcriptase Polymerase Chain Reaction (Conventional RT PCR), the newer closed system chip-based Reverse Transcriptase Polymerase Chain Reaction (Truenat RT PCR) manufactured by Molbio Diagnostics Pvt. Ltd., Goa, India and Rapid Chromatographic immunoassay for SARS-CoV-2 specific Antigen (Standard Q COVID-19 Ag Test) manufactured by SD Biosensor, Inc., Republic of Korea. Out of these, for emergency surgical patients, the Rapid Antigen testwas chosen for screening as it gives result in 20 minutes.If

patient require admission in Neurosurgery ward/ICU (Non-Covid) thenpatient and two patient attendants were tested using Truenat RT PCR, with high sensitivity and specificity, as confirmatory test. Its screening test is for detection of E (Envelop) gene and its confirmatory test is for detection of RdRp(RNA-dependent RNA-polymerase) gene of the SARS-CoV-2 virus. If patient tests positive, patient is sent to the dedicated 250 bedded Covid19 wing of our hospital for further management by the surgical team posted in the Covid ward.

Case 1: A 2 year 8 months old female child weighing 12 kgs presented to the Emergency Department of Jawaharlal Nehru Institute of Medical Sciences (JNIMS), Imphal with soft persistent swelling on the scalp for a week following fall from a height of 12 feet. Physical and neurological examinations were non-significant. There was no spinal injury or long bone fracture. X-ray skull anterio-posterior view showed a depressed fracture in right parietal region (Fig.1) Non Contrast CT (NCCT) Scan brain showed severely depressed right parietal skull fracture with a small extradural hematoma (Fig.2).Routine blood investigations and coagulation profile were done. SARS-CoV-2 detection test was done by taking nasopharyngeal swab samples.After confirming Truenat RT PCR test to be negative, the patient was scheduled for operation. Informed consent was taken from the parents. Under general anesthesia,skin incision using a 15 size blade was given and rectangular flap created on the right parietal side. Two burr holes were made manually using Hudson brace and perforator on diametrically opposite sides of the edge of the fracture. The Craniotome was specifically not used keeping in mind the creation of aerosols. Two bone elevators were inserted through the burr hole, taking precautions not to injure the underlying brain. With one end of the elevator inserted till the level of the center of the depressed fracture, it is slowly pull up giving counter pressure from outside manually. The same technique was applied from the second burr hole. After elevation of the fracture element, mini drain was also placed to prevent accumulation of blood. Anatomic layers of the skull were the closed.

Case 2: A 3-year child presented to the Emergency Department with swelling in the forehead following fall. NCCT brain revealed frontal depressed skull fracture. After routine blood investigationsand SARS-CoV-2 testing were done, he underwent surgery under general anaesthesia. A horizontal 6cm skin incision was made just above the supraorbital ridge. A small burr hole was made on the right lateral edge of the fracture through which the depressed fracture was elevated with a bone elevator. Skin was then closed with 5-0 Mersilk sutures after placing a mini drain.

Case 3: A 2-year baby presented to the Emergency Department with history of slipping away from the back of his mother while she was carrying him in a sling of cloth.Physical and neurological examination was normal. NCCT brain showed parietal depressed skull fracture. After routine and SARS-CoV-2 testing were done, he underwent surgery under general anaesthesia. Burr hole and elevation of the fracture was done.

Case 4: A 4 yearsold year male presented to the Emergency Department with swelling in the forehead resulting due to falling of object onto the head. Physical and neurological examination was normal. NCCT brain showed frontal depressed skull fracture. After routine and SARS-CoV-2 testing were done, he underwent surgery under general anaesthesia. A burr hole and elevation of the fracture was done.

III. Result:

Satisfactory reduction of the skull fracture was achieved in all the cases. Duration of the surgery was less than 30 minutes in all the cases. There were no postoperative complications and patients were discharged after 3 days. Surgical goals during this pandemic namelyminimal intervention with minimal hospital stay were achieved.

IV. Discussion:

There is nostandard treatment for depressed skull fractures.A plethora of treatment options is available to the surgeon and is chosen according to the particular patient's needs.To perform the surgery as early as possible is advisable to reduce the risk of contamination, if present[4].All such fractures were treated on an urgent or semi-elective basis[5]. **Burr holesand elevation of the fracture has been the traditional approach[5].**An elevator is inserted through the burr hole and is used to lever up the depressed skull fracture.However,this may not be applicable in all cases.

Craniectomy is also another option in which bone fragments are removed, wound debrided and the intracranial pathology corrected.The excised bone fragments are remolded and reinserted. Repair of the cranial defect can be done at a later date by doing Cranioplasty or by advocating single stage repair with titanium mesh[6]. Craniotomy/craniectomy is chosen if intracranial pathology is there such as gross contamination, dural tear with pneumocephalus, underlying hematoma, and severe brain edema.[7]Zalatimo et al[8] has described a method where **self-tapping screw** anchored to the depressed bone after making a small stab incision were pulled up.Local anaesthesia was used and hence avoiding general anaesthesia complications.

Breast pump has also been used to elevate simple depressed skull fractures. The cup of breast pump, originally made for pumping breast milk, is placed over the depressed region after application of gel which is

then connected to a suction generator for a few seconds.It is performed repeatedly while observing the scalp swelling and skull contour[3].

Another bedside procedure is using our **bare hands**. Placing our thumbs on opposite margins of the fracture and giving tangential pressure has been reported for reducing closed DSF[9]

An ideal method for treatment of deep depressed skull fractures arefactors consideringpatient safety,immediate correction of the deformity, time and cost effectiveness, and techniques that are familiar to the neurosurgeon [8.]

At the same time, the current protocols in view of the COVID-19 pandemic should be followed for safety of both the patients and healthcare providers without compromising patient safety.As SARS-CoV-2 is known to spread by aerosols, in addition to the droplet transmission, surgeons especially operating on head and neck should be cognisant of current protocols and recommendations to keep occupational exposure to a minimum.Healthcare providers make up 3.8% ofinfected SARS-CoV-2patients due to direct exposure in the work environment.In addition, healthcare providers infected during surgical procedures for cranio-maxillo-facial trauma will experience much worse disease as compared to disease through regular community transmission.It is postulated to be due to high viral inoculum generated from these highly aerosolising procedures,leading to high viral load and aggravated cytokine release and hence more severe clinical manifestations.[10]

We can take small measuresintraoperatively to limit potential aerosolization.Such measures include using a scalpel rather than monopolar cautery, using bipolar cautery on the lowest power setting for hemostasis, avoiding repeated suctioning and irrigation, avoiding power instrumentation if possible including drill preferentially using self-drilling screws, and if drilling is required, avoiding or limiting irrigation and using a low speed drill.[10]Hudson's brace and Gigli saw are advised for craniotomies as drills/craniotomes are known to be associated with significant aerosol formation.The assistant must liberally irrigate the surgical site during usage of these instruments. If drills are to be used, they must be used at lower speeds and with liberal irrigation to reduce the risk of aerosol contamination of the theatre. There is no evidence of virus concentrates in either blood or cerebrospinal fluid (CSF) and hence transcranial procedures are relatively safer.[11]

Although RAT has high specificity (99.3-100%), it has low sensitivity (50.6% to 84%) and high false negative. So, TruenatRT PCR test is further done if RAT is negative as it is most reliable with sensitivity 100% and specificity100%. Result is available within an hour which is suitable for emergency neurosurgical cases. Although conventional RT PCR is the gold standard (with sensitivity 63-78% and specificity 98%), we usually do not advise it for our surgical patients as it is time consuming requiring minimum 5 hours.[12] A test run can accommodate about 80-90 patients and practically cannot be done for a single patient.

Fig 1. Plain X ray Skull AP view

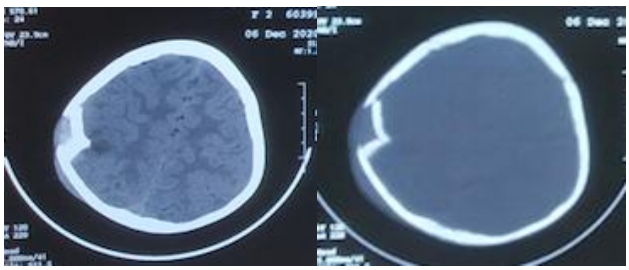

Fig 2. Preoperative CT Scan of Depressed skull fracture (DSF)

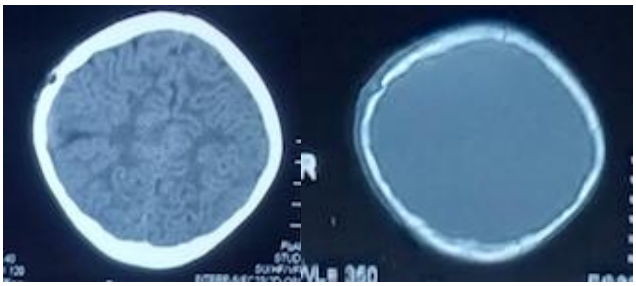

Fig 3.Post operative NCCT brain of DSF

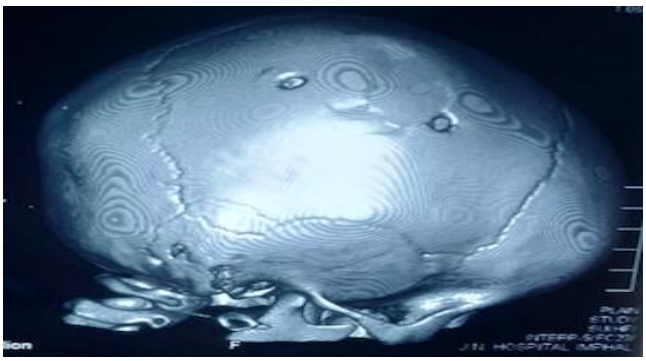

Fig 4. Post op CTScan 3D reconstruction of cranium

V. Conclusion:

With the advent of widespread SARS-CoV-2 infections, neurosurgeons should operate keeping in mindthe current protocols in order to achieve optimum care and safety for both patient and health care providers. Treatment should be tailored to the clinician decision for the type of depressed skull fracture.

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CONFLICT OF INTEREST: None

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