A journey through computed tomography findings in post operative cranium in head trauma patients

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Aims and objectives

To review imaging findings in post-operative cranium in head trauma patients.

Methods and materials

Data was collected from the hospital database related to post-operative cranium in head trauma patients who underwent computed tomography (CT) examination over a period of approximately 1 year from June 2013 to July 2014. The normal and abnormal findings along with their sequential evolution were analysed by the two radiologists and correlated clinically from the case-notes as recorded in computerized patient record system (CPRS). The patients who lost to follow up and died before the 3rd post operative day were excluded. Total 350 patients were enrolled in the study who underwent single or repeated CT examination for evaluating variable important interval imaging changes in post operative follow up.

Results

Usually four types of neurosurgical techniques (craniectomy, cranioplasty, craniotomy and burr hole) have been developed to treat patients with head trauma. Imaging is important in the routine postoperative follow-up of these patients, as well as in identifying complications. Interpreting postoperative images requires knowledge of the normal cranial anatomy (Figure 1) and the surgical technique employed, such as burr holes, craniotomy, craniectomy, and cranioplasty (Figure 2) [1].

We identified craniectomy and cranioplasty as major neurosurgical procedure (approximately 38% and 27% respectively) in head trauma patients. Craniotomy and isolated burr hole constituted remaining 20% and 15% of cases (Figure 3).

The abnormal CT imaging finding rate in our study was approximately 14% which comprised of events like complex fluid collection, infection, hemorrhage, tension pneumocephalus, herniation, and trephine syndrome (Figure 4). Most of the complication
were common to all types whereas few were rather specific for certain particular type of surgical technique (like paradoxical herniation in post craniectomy patient).

In retrospective analysis of the CT findings in our cohort patients, pneumocephalus was present in 100% of patients within 3 days of surgery (Figure 5) which reduced to 50% of patients after 15 days. No patient had e/o pneumocephalus after 20 days. The observation was consistent with previously published study [2]

Tension pneumocephalus is neurosurgical emergency that occurs when a buildup of pressure within subdural air collections compresses the brain parenchyma [2]. Few characteristic sign on CT scan (peaking' sign and the "Mount Fuji" sign) has been described [3,4]. These signs need not to be present for making a diagnosis of tension pneumocephalus in symptomatic patient with CT showing subdural air and appreciable parenchymal compression (Figure 6). Both clinical and imaging evidence of tension pneumocephalus was encountered in 3 cases (approximately 3.1 % of cranioplasty cases). 1 case resolved and improved with 100% oxygen while 2 patient needed surgical drainage.

Postoperative collection was the most common and most eye catching finding in post cranial surgery patients. It was seen in 154 patients (44%). This comprised of frank hypodense collections (reported as hygroma). Collection with thickness more than 5 mm was considered to be significant (seen in 17 cases - approximately approximately 5.7% of total cohort) as opposed to the studies published previously [5] quoting 3 mm as borderline parameter. Collection with thickness less than 5 mm did require any treatment. The external brain tamponade by fluid collection was seen in 8 cases (Figure 7) where all patients needed surgical drainage to relieve the compression over brain parenchyma [6].

Postoperative haemorrhage (intra and extraaxial) was encountered in 42 patients (10%). This consisted of significant postoperative intraaxial parenchymal haemorrhage in 5 cases (1.4% of total cohort) and extraaxial hematoma in 7 cases (2%) (Figure 8). The most common type was regional, that is bleed at the site of surgery. Remote haemorrhage (away from site of primary injury) was seen in only one case with new onset of finding in posterior fossa in 4 days’ follow UP CT of a postcraniectomy patient (Figure 9). Usually remote haemorrhage has been described within the parenchyma [7]. The remote bleed away from the site of primary imact injury in our case occured in cisterna magna.

The another clinically significant complication was observed in form of infection (4% of total enrolled subjects). Infections usually began at the line of the skin closure. It was readily diagnosed clinically. CT scan was done to identify deep extension into the bone flap, extra-axial spaces, meninges, or brain. It manifested in form of soft tissue infection (vetriculitis, meningitis, extradural abscess, subdural empyema, or brain abscess in 1,
1, 5, 4 and 2 cases respectively). We did not encounter any case of venous sinus thrombosis. Osteomyelitis was diagnosed in only one case of cranioplasty patient (Figure 10).

Cranioplasty is surgical repair of bone defect [8] created by craniectomy. Cranioplasty flap infection in form of osteomyelitis (irregular fuzzy cortical margin with lytic areas) was noticed in 1 case (Figure 10). All occurred in cranioplasty done with autologous bone harvested from bone bank. The edges of a bone flap stored in an abdominal subcutaneous cavity or in the subgaleal space for later cranioplasty was found to be remodeled. On other hand, cryopreserved bone flap showed excellent cosmetic result because of lack of remodeling. Flap infection and bone resorption are reported to occur more frequently with frozen autologous bone grafts than with fresh autografts [9] as envisaged in our observation. Lytic areas seen in bone flap is not always consistent with osteomyelitis which are routine in autoclaved or irradiated old flap (Figure 11). Such complication does not come across with acrylic or titanium mesh used for cranioplasty. The autologous bone harvested from bone bank was major cranioplasty material in our institute.

Contralateral parenchymal shift (sinking skin flap syndrome) away from craniectomy defect across the midline was seen in total 20 patient (approximately 5.7 %). Not all patients were symptomatic. The symptomatic case in these series constituted the well known although rare group of paradoxical herniation (total 2 cases - approximately 1.5 % of craniectomy patient). Treatment options include placing the patient in the trendelenburg position, clamping ventricular shunts or drains, administering intravenous fluid, performing early cranioplasty and a lumbar epidural blood patch [10]. The above patients of paradoxical herniation in our institute were treated with autologous bone cranioplasty (Figure 12).

CT in 1 patients presenting with seizure revealed focal well defined hyperdense ring structure with mild surrounding edema. The possibility of abscess verses granulomatous infection / neurocysticercois was kept. On treatment failure, histopathology was done which was suggestive of foreign body granuloma (Figure 13). Two cases of intracranially entrapped fat was also found in post cranioplasty CT. Although unusual this was considered to be unusual benign finding (Figure 14). Menigogaleal flap calcification is routine finding in old post operative case (Figure 15).

With this exhibit we have tried to depict the post operative complication in schematic way. To the best of our knowledge, the occurrence of foreign body granuloma and intracranially entrapped fat have never been reported in post traumatic post cranial surgery setting.
Normal Scalp anatomy on CT

Fig. 1: NORMAL CT ANATOMY OF SCALP
Cranial surgery

- **Burr hole**: a small hole created in the calvaria

- **Craniotomy**: removal of a skull portion with subsequent replacement

- **Craniectomy**: the removal of a skull portion without replacement

- **Cranioplasty**: the surgical repair of a skull defect

**Fig. 2**: TYPES OF CRANIAL SURGERY
Cranieotomy and cranioplasty was major surgery.

**Fig. 3:** Proportion of cranial surgery in our study

**Fig. 4:** Incidence of major complication in this retrospective study

- TP – Tension pneumocephalus
Pneumocephalus

• Inevitable after any kind of surgery

• Often occurs in subdural space anteriorly

• Resolves by itself

• No pneumocephalus - seen after 3 week

Fig. 5: Pneumocephalus
Tension Pneumocephalus

• Rare emergency: air compressing underlying lobe.

• Common after posterior fossa surgery

• Needs evacuation

• Similar finding in asymptomatic patient: Diagnosis needs clinical correlation

Fig. 6: Tension pneumocephalus in right frontal region
Brain tamponade – post cranioplasty

A: Post cranioplasty --- Tense extradural collection (arrow) with mass effect relieved by flap removal (B)

Fig. 7: Tamponade by extradural collection
Sudden decompression may cause herniation and intraparenchymal haemorrhage

Craniectomy done to relieve cerebral edema

Patient 1.

Post craniectomy – intraparenchymal haemorrhage

Patient 2

Herniation of brain – benign if craniectomy defect large

**Fig. 8:** Postoperative haemorrhage at primary site of injury
Remote hemorrhage

45 yr old male (post craniectomy) developing haemorrhage within cisterna magna (arrow) – away from site of primary impact and site of surgery

**Fig. 9:** Remote hemorrhage
Bone lysis / erosion with high HU extradural collection: soft sign of infection

A: Extradural collection (HU ~ 30) with lytic areas in bone flap (arrow in B)

**Fig. 10:** Soft sign of infection
Bone lysis / erosion can be seen with old uninfected flap

Flap harvested from bone bank

Fragmentation / resorption of bone flap common with bone bank flap
Does not reflect infection

**Fig. 11:** Old uninfected flap bone showing - lytic areas ... Not sure sign of infection in all cases.. has to correlated clinically
Paradoxical herniation with resorbed weak bone flap

Paradoxical herniation (subfalcine - arrow) treated by replacing weak bone flap with bone cement

Fig. 12: Paradoxical herniation
Foreign body granuloma

- Symptoms from months to years after surgery
- Common etiology – suture, cotton pledget
- Hyperdense on NCCT
- CECT - Resembles other ring enhancing lesion

Fig. 13: Foreign body granuloma
Post cranioplasty -- Entrapped fat..

Unusual benign finding

**Fig. 14:** Entrapped fat - Benign finding
Dystrophic meningogaleal flap calcification in old case

Fig. 15: Dystrophic meningogaleal calcification - a routine
Conclusion

Imaging plays an essential role in evaluation and follow up of post-operative cranium in head trauma patients. The radiologist must be familiar with the surgical techniques; their normal postoperative appearance and should be able to diagnose potential postoperative complication.

Personal information

References