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# Otologic injuries are frequent in pediatric patients with temporal bone fractures

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ABSTRACT

This retrospective study aimed to clarify the occurrence and types of otologic injuries in children and adolescents with skull fractures.

Files of all patients under 18 years of age who had been diagnosed with skull fractures at a tertiary trauma centre were included. The primary outcome variable was the presence of any otologic symptom or finding. Secondary outcome variables were clinically detected and radiologically detected otologic injuries. The primary predictor variable was a temporal bone fracture. Other study variables were sex, age, mechanism of injury, traumatic brain injury, and mortality.

A total of 97 patients were identified for the study. Otologic symptoms and findings were frequent (33.9%). The most common clinical findings were bleeding from the external auditory canal (18.6%) and hemotympanum (13.4%). The prevailing radiological finding was blood and/or cerebrospinal fluid in the middle ear (30.9%). Patients with fractures of temporal bone had a 29-fold risk for otologic symptoms or findings (RR 28.9, 95% CI 4.1–202.9, $p < 0.001$) relative to those who did not have a temporal bone fracture. Severe otologic complications, such as permanent hearing loss (6.2%), cerebrospinal fluid leak (5.2%), or facial nerve palsy (1%), were infrequent.

Within the limitations of the study it seems that there is the necessity of otoscopy in all pediatric patients with blunt head trauma. In case of positive otologic findings, the patient should undergo imaging and ENT consultation.



## 1. Introduction

The temporal bone is a complex structure comprising the squamous, petroid, mastoid, and tympanic regions. In addition to serving as sites for muscle attachments, the temporal bone incorporates several openings and canals for nerves and significant blood vessels. The temporal bone also surrounds the external auditory canal and houses the structures that form the middle and inner ear. Fractures of the temporal bone may thus cause significant nerve and vascular lesions as well as injuries to the hearing chain and the hearing organ itself.

Detailed studies have revealed that hemotympanum (21.8–78.1%) (Schubl et al., 2016; Kanona et al., 2020, Ricciardiello et al., 2021), blood otorrhea (34.5–89.8%) (Schubl et al., 2016, Ricciardiello et al., 2021), and perforation of the tympanic membrane (35.2%) (*Ricciardiello et al., 2021*) are frequent clinical signs of temporal bone fractures in adult patients. Other otologic complications have been far more infrequent; facial nerve palsy has been reported in 1.8–15.2% and cerebrospinal fluid leak from the ear in

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1.8–7.9% of adult patients with temporal bone fractures (Schubl et al., 2016; Kanona et al. 2020, Ricciardiello et al., 2021).

Due to ongoing growth and development, craniofacial fractures in children differ from those in adults in many aspects. Trauma mechanisms, the relative proportions between the skull and the face (Imahara et al., 2008), and sizes and pneumatization of the paranasal sinuses (Thorén et al., 2011) are some features that change markedly with increasing age, predisposing children of different ages to different types of fracture patterns. Regarding the temporal bone in particular, a high degree of bone elasticity and incomplete pneumatization of the mastoid region may likewise affect not only temporal fracture patterns but also the nature of associated otologic complications. With the exception of studies focusing on predictors for and occurrence of post-traumatic hearing loss, to date not much has been reported about otologic injuries in pediatric patients with skull and temporal bone fractures.

In the present study, it was hypothesized that otologic symptoms and findings are frequent in children and adolescents with skull fractures, and that factors associated with otologic symptoms and findings exist that should alert the traumatologist to take appropriate actions regarding diagnosis and treatment. Therefore, the aim of this study was to clarify the occurrence and types of otologic symptoms and findings in young patients with skull fractures in general and temporal bone fractures in particular.

## 2. Materials and methods

### 2.1. Study design

To address the research aims, a retrospective, cross-sectional cohort study was designed and implemented. We included all patients aged under 18 years of age who had been diagnosed with skull fractures at the Children's Hospital or at the Töölö Hospital Emergency Department, Helsinki University Hospital, between 1 January 2013 and 31 December 2018. The search of the hospital database was based on *International Classification of Diseases, Tenth Revision* (*ICD-10*) codes for fractures of the skull and facial bones (subsection S02). Included were the files of patients who had sustained one or more skull fractures and who had available imaging data of the fractures, i.e., computed tomography (CT) scans, magnetic resonance imaging (MRI), conventional skull X-rays, and/or ultrasound imaging. Patients' files were reviewed in detail, and demographic and clinical study variables were collected manually. Radiological images were reviewed, and types of skull fractures and otologic injuries were identified.

### 2.2. Study variables

The primary outcome variable was the presence of any otologic symptom or finding (yes/no), including clinically and/or radiologically detected otologic findings.

Secondary outcome variables were clinically detected otologic injury (yes/no) and radiologically detected otologic injury (yes/no). Based on entries that had been made into the patient files, clinically detected otologic injuries were classified as follows: external auditory canal bleeding, cerebrospinal fluid leak from the ear, tympanic membrane perforation, hemotympanum, tinnitus, permanently impaired hearing (i.e., PTA >20 dB at least 6 months after injury), and facial nerve palsy. Radiologically detected otologic injuries were classified as follows: blood and/or cerebrospinal fluid in the middle ear cavity, injury to the auditory ossicles (i.e., dislocations or fractures), and involvement of the otic capsule (i.e., fracture penetrating the bony labyrinth).

The primary predictor variable was temporal bone fracture at the side of otologic injury.

Other study variables were sex, age, mechanism of injury, presence of traumatic brain injury, and mortality during hospital stay. Injury mechanisms were grouped as follows: fall on ground level, fall from height, fall from stairs, motor vehicle accident, bicycle accident, assault, and struck by object/other impact. Brain injuries were further classified according to their anatomical location as subdural, epidural, subarachnoid, and intracerebral. In addition, the numbers of the above classified anatomical locations of brain injuries were recorded.

### 2.3. Statistical analyses

The Mann–Whitney *U* test, $\chi^2$ test, Fisher's exact test, or Cramer V was performed to evaluate the differences between study variables and outcome variables and between predictors and study variables. Pairwise comparisons were executed with a z or binomial test. Risk ratios with 95% confidence intervals were calculated to examine the risk between primary predictor and outcome variables. Multiplicity was corrected with the Bonferroni method. Statistical significance was set at $p < 0.05$. Statistical analyses were performed using SPSS software (IBM SPSS V27.0, IBM Corp., Armonk, NY, USA).

### 2.4. Ethical considerations

This research involved only patient charts and imaging studies; therefore, no formal Research Ethics Board approval was needed according to Finnish legislation. Institutional research permission was granted by Helsinki University Hospital, Helsinki, Finland (HUS/356/2017).

## 3. Results

A total of 97 patients fulfilled the inclusion criteria. Twenty-one of these patients, all of whom were less than 1 year of age, had undergone only ultrasound imaging and/or conventional skull X-ray imaging. In the rest, CT scans (18 patients), MRI (12 patients), or a combination of CT and MRI (46 patients) had been performed.

Descriptive statistics of the 97 patients are presented in Table 1. The majority of patients were male (57.7%). The mean age was 7.1 years (median 5.7 years). Fall from height was by far the most common injury mechanism (45.4%). Temporal bone fractures occurred in 51 patients (52.6%) and traumatic brain injuries in 56 patients (57.7%). The mortality rate was 5.2%. Any otologic symptom or finding was observed in 33 patients (34.0%). Otologic injuries were detected clinically in 28 patients (28.9%) and radiologically in 30 patients (30.9%). Of the 97 children with skull fractures and primary otolaryngological examination, 24 had been referred for further consultation to the ear, nose, and throat (ENT) clinic.

Table 2 shows the distribution of skull and temporal bone fractures in more detail. The most common type of skull fracture involved at least two skull bones (44.3%). Temporal bone fractures occurred in isolation in 11 patients and in combination with other skull fractures in 40 patients. Of the 51 patients with temporal bone fractures, 38 (74.5%) had a unilateral temporal bone fracture and 41 (80.4%) had fractures of the petromastoid bone. As shown in Fig. 1, the proportion of temporal fractures increased from 10.3% in infants to 82.6% in patients aged 13 years or more.

Table 3 shows the anatomical locations and number of locations of traumatic brain injuries. Of 56 patients with a traumatic brain injuries, the majority (73.2%) had an intracerebral injury and 46.5% had a combination of injuries in two or more locations. As shown in Fig. 1, the proportion of traumatic brain injuries increased from 6.9% in infants to 95.7% in those aged 13 years or more.

**Table 1**
Patient demographics and injury-related factors in a series of young patients (N = 97).

| Characteristic | No. of patients | % of 97 patients |
|---|---|---|
| **Sex** | | |
| Boys | 56 | 57.7 |
| Girls | 41 | 42.3 |
| **Age (years)** | | |
| Range 0.00–17.95 | | |
| Mean 7.1 | | |
| Median 5.7 | | |
| **Mechanism of injury** | | |
| Fall from height | 44 | 45.4 |
| Motor vehicle accident | 19 | 19.6 |
| Struck by object/other impact | 14 | 14.4 |
| Fall on ground level | 11 | 11.3 |
| Bicycle accident | 5 | 5.2 |
| Fall from stairs | 2 | 2.1 |
| Assault | 2 | 2.1 |
| **Temporal bone fracture** | | |
| Yes | 51 | 52.6 |
| **Traumatic brain injury** | | |
| Yes | 56 | 57.7 |
| **Mortality** | | |
| Yes | 5 | 5.2 |
| **Any otologic symptom or finding**[a] | | |
| Yes | 33 | 34.0 |
| **Clinically detected otologic injury** | | |
| Yes | 28 | 28.9 |
| **Radiologically detected otologic injury** | | |
| Yes | 30 | 30.9 |
| **ENT consultation** | | |
| Yes | 24 | 24.7 |

[a] Including clinically and/or radiologically detected otologic injuries.

Table 4 shows the distribution of otologic symptoms and findings in more detail. In the 28 patients with clinically detected otologic injuries, the most common findings were external auditory canal bleeding (64.3%) and hemotympanum (46.4%). Altogether, eight patients had trauma-induced impaired hearing at the early stage, but in two, hearing normalized during follow-up. Permanently impaired hearing occurred in six patients (6.2%), all of whom had sustained temporal bone fracture. Two of the hearing losses were sensorineural, one was conductive, and three were mixed. In the 30 patients with radiologically detected otologic injuries, the prevailing finding was blood and/or cerebrospinal fluid in the middle ear (100%).

Table 5 shows some differences between other study variables and presence versus absence of temporal bone fracture. Mean and median age were higher in patients with temporal bone fracture than in those without ($p < 0.001$). In addition, being struck by an object/other impact ($p = 0.035$) and brain injury ($p < 0.001$) were significantly more common in patients with temporal bone fracture. Fall from height ($p = 0.004$) was more common among patients without temporal bone fracture.

Table 6 shows the associations between other study variables and presence versus absence of otologic symptoms or findings. Mean and median age were higher in patients with any otologic symptoms or findings than in those without ($p = 0.0019$). There was also a significant association between any otologic symptoms or findings and mortality ($p = 0.044$). Fall from height, on the other hand, associated significantly with absence of any otologic symptom or finding ($p < 0.001$).

Table 7 shows the associations between outcome variables and presence versus absence of temporal bone fracture. Any otologic symptoms or findings were observed in 62.7% of the 51 patients with temporal bone fracture. All but one patient with any otologic symptom or finding had associated temporal bone fracture on the ipsilateral side ($p < 0.001$). Otologic symptoms or findings occurred without temporal bone fracture in one patient, who had hemotympanum and exclusively parietal bone fracture in imaging studies.

As shown in Table 8, patients with fractures of the temporal bone had a 29-fold risk of any otologic symptom or finding (RR 28.9, 95% CI 4.1–202.9, $p < 0.001$) and a 24-fold risk of clinically detected otologic injury (RR 24.4, 95% CI 3.4–172.2, $p = 0.0014$) relative to those who did not have a temporal bone fracture.

## 4. Discussion

In the present study, it was hypothesized that otologic symptoms and findings are frequent in children and adolescents with skull fractures, and that factors associated with otologic symptoms and findings exist that should alert the traumatologist to take appropriate actions regarding diagnosis and treatment. Therefore, the aim of this study was to clarify the occurrence and types of otologic symptoms and findings in young patients with skull fractures in general and temporal bone fractures in particular.

The hypothesis was confirmed. Otologic symptoms and findings were frequent, occurring in one in three patients. In the great majority of patients with otologic symptoms or findings (28 of 33), the injuries could be detected on clinical examination. The most common clinical findings were bleeding from the external auditory canal and hemotympanum, whereas the predominant radiological finding was blood and/or cerebrospinal fluid in the middle ear. Of 51 young patients with temporal bone fractures, 62.7% had one or more otologic symptoms or findings present. Patients with a fracture of the temporal bone had a 29-fold risk for otologic symptoms or findings ($p < 0.001$) relative to those who did not have a temporal bone fracture. Severe otologic complications, such as

**Table 2**
Types and sites of skull and temporal bone fractures in young patients (N = 97).

| Fracture | No. of patients | % of 97 patients | % of 51 patients with temporal bone fractures |
|---|---|---|---|
| **Type of skull fracture** | | | |
| Fractures involving 2 or more skull bones | 43 | 44.3 | |
| Fractures involving the parietal bone exclusively | 33 | 34.0 | |
| Fractures involving the temporal bone exclusively | 11 | 11.3 | |
| Fractures involving the frontal and/or sphenoidal bone exclusively | 8 | 8.2 | |
| Fractures involving the occipital bone exclusively | 2 | 2.1 | |
| **Type of temporal bone fracture** | | | |
| Unilateral | 38 | 39.2 | 74.5 |
| Bilateral | 13 | 13.4 | 25.5 |
| **Site of temporal bone fracture** | | | |
| Petromastoid bone | 41 | 42.3 | 80.4 |
| Isolated fracture confined to temporal suture | 14 | 14.4 | 27.5 |
| Other | 9 | 9.3 | 17.6 |

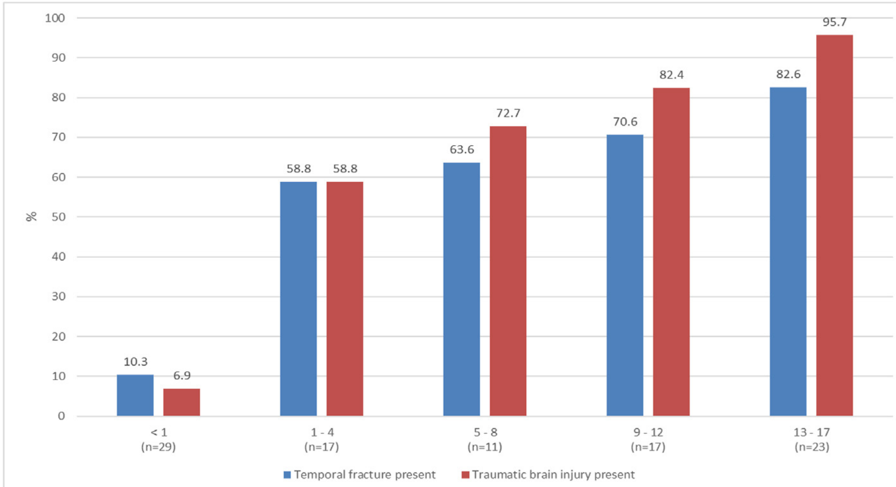


**Fig. 1.** Proportions of temporal bone fractures and traumatic brain injuries per age group.

**Table 3**
Distribution of anatomical locations and number of locations of traumatic brain injuries in young patients with skull fractures (N = 97).

| | No. of patients | % of 97 patients | % of 56 patients with traumatic brain injuries |
|---|---|---|---|
| **Traumatic brain injury** | | | |
| Yes | 56 | 57.7 | |
| **Anatomical location** | | | |
| Intracerebral | 41 | 42.3 | 73.2 |
| Subdural | 24 | 24.7 | 42.9 |
| Subarachnoidal | 15 | 15.5 | 26.8 |
| Epidural | 14 | 14.4 | 25.0 |
| **No. of locations** | | | |
| 1 | 30 | 30.9 | 53.6 |
| 2 | 16 | 16.5 | 28.6 |
| ≥3 | 10 | 10.3 | 17.9 |

**Table 4**
Types of clinically and radiologically detected otologic injuries in young patients with skull fractures (N = 97).

| | No. of patients | % of 97 patients | % of 28 patients with clinically detected otologic injuries | % of 30 patients with radiologically detected otologic injuries |
|---|---|---|---|---|
| **Clinically detected otologic injuries** | | | | |
| Yes | 28 | 28.9 | | |
| External auditory canal bleeding | 18 | 18.6 | 64.3 | |
| Hemotympanum | 13 | 13.4 | 46.4 | |
| Permanently impaired hearing (>6 months after injury) | 6 | 6.2 | 21.4 | |
| Cerebrospinal fluid leak from ear | 5 | 5.2 | 17.9 | |
| Tympanic membrane perforation | 5 | 5.2 | 17.9 | |
| Tinnitus | 3 | 3.1 | 10.7 | |
| Facial nerve palsy | 1 | 1.0 | 3.6 | |
| **Radiologically detected otologic injuries** | | | | |
| Yes | 30 | 30.9 | | |
| Blood and/or cerebrospinal fluid in middle ear | 30 | 30.9 | | 100.0 |
| Auditory ossicle involvement | 9 | 9.3 | | 30.0 |
| Otic capsule involvement | 3 | 3.1 | | 10.0 |

permanent hearing loss, cerebrospinal fluid leak, or facial nerve palsy, were infrequent.

In young patients with a temporal bone fracture, hearing loss has been reported to occur in 16–56% (Frisenda et al., 2015; Schell and Kitsko, 2016; Waissbluth et al., 2016; Dedhia et al., 2020), facial nerve palsy in 5–15% (Ort et al., 2004; Dunklebarger et al., 2014; Wexler et al., 2017; Dedhia et al., 2020), and cerebrospinal fluid leak from the ear in 3–7% (Ort et al., 2004; Dedhia et al., 2020). The 5.2% rate of patients with cerebrospinal fluid leak from the ear in the present study lies within the range of that reported previously. Facial nerve palsy and especially hearing loss, on the other hand, were notably more infrequent in the present study. One reason for the low rate of impaired hearing in particular is that we included only permanent hearing losses, i.e., hearing losses that had persisted for at least 6 months after injury. Frequencies of early-stage impaired hearing may be much higher due to otologic injuries, which, if not accompanied by other risk factors, generally heal well spontaneously.

**Table 5**
Associations between other study variables and presence versus absence of temporal bone fracture in young patients with skull fractures (N = 97).

| Variable | Patients with a temporal bone fracture (n = 51) | % of 51 | Patients without a temporal bone fracture (n = 46) | % of 46 patients | p value* |
|---|---|---|---|---|---|
| **Sex** | | | | | 0.293[a] |
| Boys | 32 | 62.7 | 24 | 52.2 | |
| Girls | 19 | 37.3 | 22 | 47.8 | |
| **Age (years)** | | | | | <0.001[b] |
| Range | 0.10–17.95 | | 0–15.11 | | |
| Mean | 10.23 | | 3.58 | | |
| Median | 10.5 | | 0.67 | | |
| **Mechanism of injury** | | | | | 0.030[c] |
| Fall from height | 16 | 31.4 | 28 | 60.9 | 0.004[d] |
| Motor vehicle accident | 12 | 23.5 | 7 | 15.2 | >0.05[d] |
| Struck by object/other impact | 11 | 21.6 | 3 | 6.5 | 0.035[d] |
| Fall on ground level | 7 | 13.7 | 4 | 8.7 | >0.05[d] |
| Bicycle accident | 3 | 5.9 | 2 | 4.3 | >0.05[d] |
| Fall from stairs | 0 | 0 | 2 | 4.3 | NA |
| Assault | 2 | 3.9 | 0 | 0 | NA |
| **Brain injury** | | | | | <0.001[a] |
| Yes | 39 | 76.5 | 17 | 37.0 | |
| **Mortality** | | | | | 0.058[e] |
| Yes | 5 | 9.8 | 0 | 0 | |

*Bonferroni corrected.
[a] $\chi^2$ Test.
[b] Mann–Whitney *U* test.
[c] Cramer V.
[d] z Test.
[e] Fisher's exact test.

**Table 6**
Associations between other study variables and presence versus absence of otologic symptoms or findings in young patients with skull fractures (N = 97).

| Variable | Population | Any otologic symptom or finding present* | % of patients | No otologic symptom or finding present | % of patients | p value** |
|---|---|---|---|---|---|---|
| | | No. of patients | | No. of patients | | |
| **All patients** | 97 | 33 | 34.0 | 64 | 66.0 | |
| **Sex** | | | | | | 0.201[a] |
| Boys | 56 | 22 | 39.3 | 34 | 60.7 | 0.999[b] |
| Girls | 41 | 11 | 26.8 | 30 | 73.2 | 0.048[b] |
| **Age (years)** | | | | | | 0.0019[c] |
| Range | | 0,05–17,95 | | 0,00–17,93 | | |
| Mean | | 10,22 | | 5,45 | | |
| Median | | 10,14 | | 3,7 | | |
| **Mechanism of injury** | | | | | | 0.013[d] |
| Fall from height | 44 | 8 | 18.2 | 36 | 81.8 | <0.001[b] |
| Motor vehicle accident | 19 | 8 | 42.1 | 11 | 57.9 | 0.999[b] |
| Struck by object/other impact | 14 | 9 | 64.3 | 5 | 35.7 | 0.999[b] |
| Fall on ground level | 11 | 4 | 36.4 | 7 | 63.6 | 0.999[b] |
| Bicycle accident | 5 | 2 | 40.0 | 3 | 60,0 | 0.999[b] |
| Fall from stairs | 2 | 0 | 0 | 2 | 100.0 | NA |
| Assault | 2 | 2 | 100.0 | 0 | 0 | NA |
| **Brain injury** | | | | | | 0.032[a] |
| Yes | 56 | 24 | 42.9 | 32 | 57.1 | 0.999[b] |
| **Mortality** | | | | | | 0.044[e] |
| Yes | 5 | 4 | 80.0 | 1 | 20.0 | 0.999[b] |

*Including clinically and/or radiologically detected otologic injuries.
**Bonferroni corrected.
[a] $\chi^2$ test.
[b] Binomial test.
[c] Mann–Whitney *U* test.
[d] Cramer V.
[e] Fisher exact test.

Several previously published studies have attempted to identify anatomical features of temporal bone fractures that would predict the risk for severe otologic complications. For this purpose, temporal fractures have been classified based on otic capsule involvement (i.e., otic capsule violating vs. sparing fractures) and orientation of the fractures with respect to the axis of the petrous bone (i.e., longitudinal vs. transverse fractures). The results obtained are controversial. Some authors have found an association between sensorineural hearing loss and otic capsule violating fractures (Dunklebarger et al., 2014; Frisenda et al., 2015; Dedhia et al., 2020) and transverse fractures (Dunklebarger et al., 2014; Dedhia et al., 2020). Fractures violating the otic capsule have also been associated with higher rates of cerebrospinal fluid leak from the ear and with facial nerve palsy (Dedhia et al., 2020). However, other authors have not found any associations between the classification systems and hearing loss (Wexler et al., 2017) or facial nerve palsy (Wexler et al., 2017, Dunklebarger et al., 2014). The complication rates in the present study are far too small for

**Table 7**
Associations between outcome variables and presence versus absence of a temporal bone fracture in young patients with skull fractures (N = 97).

| Variable | Patients with a temporal bone fracture present (n = 51) | % of 51 patients | Patients with a temporal bone fracture absent (n = 46) | % of 46 patients | p value |
|---|---|---|---|---|---|
| **Any otologic symptom or finding*** | | | | | |
| Yes | 32 | 62.7 | 1 | 2.2 | <0.001[a] |
| **Clinically detected otologic injury** | | | | | |
| Yes | 27 | 52.9 | 1 | 2.2 | <0.001[a] |
| **Radiologically detected otologic injury** | | | | | |
| Yes | 30 | 58.8 | 0 | 0 | <0.001[a] |

*Including clinically and/or radiologically detected otologic injuries.
[a] Fisher exact test.

**Table 8**
Risk analysis between primary predictors and outcome variables.

| | Any otologic symptom or finding[a] | Clinically detected otologic injury | Radiologically detected otologic injury |
|---|---|---|---|
| | RR (95% CI) | RR (95% CI) | RR (95% CI) |
| **Temporal bone fracture present** | 28.9 (4.1–202.9) | 24.4 (3.4–172.2) | NA |
| **Temporal bone fracture absent** | reference group | reference group | reference group |
| p Value | <0.001 | 0.0014 | NA |

CI = confidence interval; NA = not applicable; RR = risk ratio.
[a] Including clinically and/or radiologically detected otologic injuries.

meaningful statistical analysis of radiological predictors. Yet, our findings highlight the fact that temporal bone fracture is, indeed, the major skull fracture predicting otologic complications.

The two most frequent clinically detected otologic findings in the present cohort were bleeding from the external auditory canal (18.6%) and hemotympanum (13.4%). Hemotympanum has been shown to be the most common single aberrant otoscopy finding in children with temporal bone fracture (Waissbluth et al., 2016), whereas bleeding from the ear canal may be associated with a combination of fractures of the tympanal region and mandibular condyle fracture (Evain et al., 2021). The high frequency of otologic findings in patients with a temporal bone fracture highlight the importance of otoscopy in all patients who have sustained blunt head trauma. Aberrant otologic findings should alert the clinician to suspect a fracture, and appropriate imaging should be carried out (Fig. 2). Referral to ENT consultation for further evaluation and follow-up should be carried out.

Our study cohort included 97 children and adolescents. Infants less than 1 year of age comprised a substantial group (almost one-third) of skull fracture patients. In this age group, however, fracture patterns differ from those in older patients; parietal fissures were most common and fractures extending to the temporal bone were rare, as relatively large head and open sutures influence the impact site and fracture course. A recent study from Australia (Leung and Levi, 2020) reported 90 temporal bone fractures in 528 children with skull fractures (17%); none of these children was younger than 12 months of age. In a study by Waissbluth et al. (2016) from Canada, the rate of children with temporal bone fractures among skull base fracture patients was 19%. The large proportion (71%) of temporal bone fractures found in all children over 1 year of age with skull fractures is noteworthy.

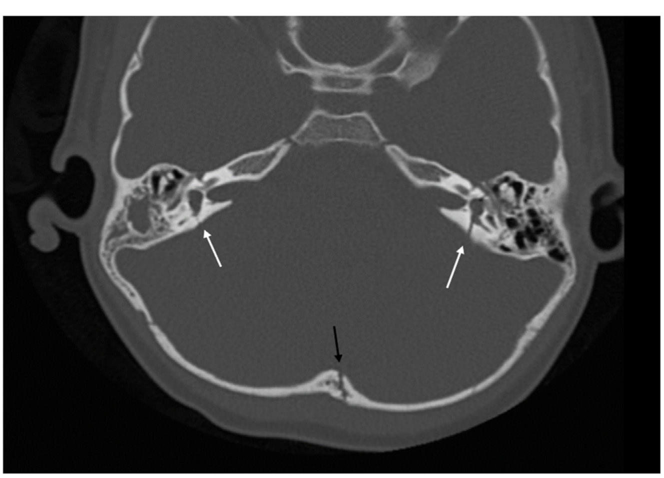

**Fig. 2.** Injury to a 4-year-old child who fell from a height of less than 2 m. Axial image of computed tomographic scan shows an occipital fracture (black arrow) and a bilateral transversal fracture of the temporal bone (white arrows) with involvement of the otic capsule. Fluid is seen in mastoid air cells and tympanic cavities.

In addition to temporal bone fractures, maxillofacial fractures in general and mandibular condyle fractures in particular also may associate with otologic trauma. As shown by Jiang et al. (2022), of a total of 437 condylar fractures, 59 (13.5%) were found with external auditory canal fractures. In the majority of cases, auditory canal fractures were associated with fractures of the condylar head, i.e., sagittal (44.7%) or intracapsular (35.6%) condylar fractures. In patients who had undergone simultaneous treatment for condylar and auditory canal fracture, no stenoses or hearing losses were observed. However, for 24 ears that had not undergone operation, all auditory canals showed different degrees of stenosis, local granulation tissue, and scar formation. The authors emphasize the importance of early treatment of external auditory canal fractures.

The main limitation of this study is the small patient pool due to the rarity of skull fractures in young patients. In addition, only 24 of the patients had been referred for ENT consultation, and therefore, the frequency of otologic symptoms and findings may be somewhat underestimated. Moreover, a longer follow-up time might reveal more patients recovering from their hearing loss.

## 5. Conclusion

Within the limitations of the study it seems that there is the necessity of otoscopy in all pediatric patients with blunt head trauma. In case of positive otologic findings, the patient should undergo imaging and ENT consultation.

## Declaration of competing interest

None

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