Accuracy of High Resolution Computed Tomography in Locating Facial Nerve Injury Sites in Temporal Bone Trauma

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Facial paralysis is a severely disfiguring complication of temporal bone fractures which occurs in 7-10% of these patients.
Introduction

- High resolution multislice computed tomography (HRCT) of the temporal bone is routinely required for evaluation of traumatic facial paralysis.

- HRCT can **show the course of the fracture line and demonstrate its relation with the fallopian canal**. It can also reveal the associated lesions such as ossicular chain disruption.
Introduction

- HRCT is known to be the best method for evaluating the intratemporal course of the facial nerve, but it has some limitations as well.

- There are limited data in recent medical publications evaluating the diagnostic value of temporal bone HRCT in the evaluation of traumatic facial paralysis.
Objective

- In this study, we have compared the findings of preoperative multislice HRCT with surgical findings in order to determine the diagnostic value of CT.
Materials & Methods
Materials & Methods

- Patients with traumatic facial paralysis who met the criteria for surgical decompression were included in our study.

- They were all grade VI paralysis, according to House-Brackmann paralysis scale.
Materials & Methods

- A thorough history was taken according to:
  - demographic data
  - The mechanism of the trauma
  - The date of trauma
  - The site of paralysis (Right, Left)
  - The time of paralysis (immediate, delayed, unknown)
  - Presence of Tinnitus, Otorrhea, True vertigo
Materials & Methods

- Physical examination included:
  - Otoscopy
  - Tuning fork examination

- Paraclinical:
  - Audiometry: SRT, SDS, PTA, Tympanometry
  - Electrophysiological tests: Eletroneurography & electromyography
Materials & Methods

- All patients underwent HRCT of both temporal bone using a 16-slice spiral computed tomography (Neosoft).

- They were all reported *blindly* by one radiologist with experience in reporting petrous CT images (MPR).
Materials & Methods

The location where the radiologist was requested to consider were:

- The cortex of mastoid
- The squamous part of temporal bone
- External auditory canal
- Scutum
- Tegmen
- the medial wall of the Antrum
- TMJ
- The mastoidian segment of facial nerve canal
- The tymanic segment of facial nerve canal
- semicircular canals
- Cochlea
- Internal Auditory Canal
Materials & Methods

• The decompression surgery were all accomplished by a neurootologist (MR).

• The data were gathered according to:
  • surgical approach (post auricular transmastoid, or trans labyrinthine or middle cranial fossa)
  • Presence or absence of fracture line
  • The ossicles condition
  • The tympanic membrane
  • The Facial Nerve condition
Materials & Methods

- The facial nerve condition:
  - normal
  - edema
  - dehiscence
  - bone chips
  - neuroma
  - partial cut
  - complete cut

- The traumatised region:
  - Perigeniculate
  - Tymanic
  - Pyramidal genu
  - Mastoidian
  - Labyrinthine
Materials & Methods

- The data was analyzed with SPSS16, with Chi Square test.
Results

- 41 patients with complete traumatic facial paralysis who met the criteria for surgical decompression between 2008 and 2012 entered this study.

- The mean age was 22.6 years with a standard deviation (SD) of 13.23 years.
Results

- In 36 patients the etiology was motor vehicle accidents, while in 5 others the paralysis were due to falling from a height or falling of a heavy object (television in a child) or roof collapses.

- In 63.4%, the onset of the paralysis was immediate, while in 36.6% the onset was undetermined.
Results

- Conductive hearing loss was present in 18 patients, 9 patients had sensorineural hearing loss, and 2 had mixed hearing loss.

- Seven patients had anacusis due to trauma.
Results

- We used the postauricular transmastoid approach in 32 (78.1%) patients.

- In order to examine the tympanic and perigeniculate area of the nerve, incus was removed and malleus head was nipped in all these 32 cases and ossicular reconstruction was performed at the end of surgery.
Results

- In **seven** (17.9%) patients the translabyrinthine approach was employed due to preoperative profound sensorineural hearing loss.

- The middle cranial fossa approach combined with the transmastoid approach was chosen in **two** patients.
Results

- The most common fractured site was the **tegmen tympanicum** (43.6%).

- The **squamous part of the temporal bone** and the **posterior wall of the external auditory canal** were the second and third most common locations.

- The **IAC and the cochlea** were the least common fracture sites.
The frequency of fracture site based on surgical findings

<table>
<thead>
<tr>
<th>The fracture site</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cortex</td>
<td>12 (30.8)</td>
</tr>
<tr>
<td><strong>Squamous part</strong></td>
<td>15 (38.5)</td>
</tr>
<tr>
<td>Posterior external auditory canal</td>
<td>14 (35.9)</td>
</tr>
<tr>
<td>Scutum</td>
<td>8 (20.5)</td>
</tr>
<tr>
<td><strong>Tegmen</strong></td>
<td>17 (43.6)</td>
</tr>
<tr>
<td>Antrum</td>
<td>11 (28.2)</td>
</tr>
<tr>
<td>Mastoid segment of fallopian canal</td>
<td>2 (5.1)</td>
</tr>
<tr>
<td>Tympanic segment of fallopian canal</td>
<td>3 (7.7)</td>
</tr>
</tbody>
</table>
Results

- The facial nerve was normal in 9 (22%) patients.

- Edema was documented in 18 patients, while 17 had a nerve dehiscence.

- Neuroma, compression with bone chips and complete cuts were infrequent findings.
The facial nerve surgical findings

- Normal
- Edema
- Dehiscence
- Neuroma
- Bone Chips
- Complete Cut

**Facial Nerve**
Results

- The **perigeniculate area** was the most commonly involved region (46.34%) of the facial nerve.

- The **tympanic segment** and the **pyramidal genu** were the second and third common locations of injury (31.7% and 12%, respectively).
The involved facial nerve segments based on surgical findings

Facial Nerve Segments
The overall sensitivity and specificity of HRCT to detect a fracture line were 77.5% and 77.7%, respectively.

The sensitivity of HRCT to detect the fracture was highest in the mastoid cortex (91.6%) and then the squamous part of the temporal bone (78.5%), and was lowest in the medial wall of the attic and the antrum (10%).

The specificity was highest in the scutum (96.5%) and then the mastoid segment of the facial nerve (94.11%), while it was lowest in the mastoid cortex (50%).
The sensitivity and specificity of the CT scan according to fracture site

<table>
<thead>
<tr>
<th>The Fracture Site</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mastoid Cortex</td>
<td><strong>91.6</strong></td>
<td>50</td>
</tr>
<tr>
<td>Squamous part</td>
<td>78.57</td>
<td>57.4</td>
</tr>
<tr>
<td>Posterior wall of the external auditory canal</td>
<td>69.23</td>
<td>85.71</td>
</tr>
<tr>
<td>Scutum</td>
<td>57.14</td>
<td><strong>96.5</strong></td>
</tr>
<tr>
<td>Tegmen</td>
<td>56.25</td>
<td>63.15</td>
</tr>
<tr>
<td>Antrum</td>
<td><strong>10</strong></td>
<td>88</td>
</tr>
<tr>
<td>Mastoid segment of fallopian canal</td>
<td>50</td>
<td><strong>94.11</strong></td>
</tr>
<tr>
<td>Tympanic segment of fallopian canal</td>
<td>33.33</td>
<td>64.51</td>
</tr>
</tbody>
</table>
Discussion
Discussion

- In traumatic facial paralysis, HRCT is the preferred modality due to its ability to demonstrate the details of osseous structures and the fracture line.

- There are limited data relating to the diagnostic value of HRCT in evaluating traumatic facial paralysis.
The **perigeniculate** is the most commonly injured area of the nerve followed by the **tympanic segment** and the **pyramidal genu**.

Similarly, in almost all other studies, the first rank belongs to the **perigeniculate area**.
Discussion

- Edema and dehiscence of the facial nerve were the two main findings of our study.

- Hematoma, bone chips and edema were the three most common findings in Yetiser’s study.

- While Darrouzet reported edema and hematoma as the top findings, Ulug found fibrosis and bone chips as the most frequent damages to the facial nerve.
Guo et al evaluated the diagnostic value of HRCT in traumatic facial paralysis and reported predictive diagnostic accordance rates of above 90%. 

In our study, the overall sensitivity and specificity of HRCT to detect a fracture line were 77.5% and 77.7%, respectively.
Discussion

- Depending on fracture locations, the **cortex of the temporal bone had the highest** and the **medial wall of the antrum had the lowest sensitivity**.

- The imaging sensitivity in this area may have been limited by its complex three-dimensional anatomy.

- The **scutum** had the **highest specificity**. This may be explained by its characteristic appearance in the coronal plane of HRCT, in which the fracture line can be easily identified.
Discussion

- The **lowest specificity** belongs to the **mastoid cortex**.

- This may be due to the fact that not all the mastoid cortex was exposed in the surgical field, so there were some fractures on HRCT that the surgeon didn't need to expose for a mastoidectomy.
Discussion

- Regarding the facial nerve canal, the sensitivity and specificity of the mastoid segment is higher than those of the tympanic segment. This could be due to the slanted route of the tympanic segment (the angle with the axial plane of imaging) or the thin shell of bone canal lateral to the nerve.
- However, the mastoid segment is surrounded by bone with air-cells and has a longer vertical course compared with that of the tympanic segment, so the fracture line is more evident in this segment.
Discussion

• Finally, based on this study, the temporal CT scan accuracy varies according to fracture site.

• Due to the low rate of false negative in mastoid cortex fracture, squamous part and external auditory canal, we can rely on normal appearance of these locations in CT scan.

• On the other hand, because the antrum and tympanic segment of the facial nerve, had the largest false negative results, the normal CT scan findings in these area, cannot rule out facial nerve injury.
Discussion

- Conversely, the **scutum, mastoid segment of facial nerve and semicircular canals** had the lowest false positive rates, thus noticing the fracture line in these sites in CT; the surgeon must be ready to handle them.

- On the other hand, the **mastoid cortex and squamous part** of the temporal bone had the largest amount of false positives, which should be born in mind by the surgeons.
Conclusion

- Although HRCT is the modality of choice in traumatic facial paralysis, the diagnostic value could differ according to the fracture location.

- The results of HRCT should, therefore, be considered with caution.