Original Article

Traumatic intracranial hemorrhages in patients with maxillofacial / jaw fractures

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ABSTRACT Patients sustaining maxillofacial fractures are at risk of accompanying traumatic intracranial hematomas, which are a major cause of morbidity and mortality. Prompt recognition of the clinical signs, followed by a neurosurgical inspection and diagnosis, is crucial for improving patient survival and recovery. To look for a relationship between the pattern of maxillofacial fractures and the risk of an intracranial hemorrhage, this retrospective study examined the records of 188 patients with maxillofacial fractures treated at the Division of Oral and Maxillofacial Surgery, Kagawa Prefectural Central Hospital, Kagawa, Japan, between January 2005 and June 2008. The patients' age, gender, cause, type, and location of maxillofacial fracture, and the intracranial injuries, were analyzed. Intracranial hemorrhage occurred in 17 patients (9.0%) and included intracerebral (6.4%), subarachnoid (4.8%), subdural (3.7%), and epidural (0.5%) hemorrhages. Central mid-face (LeFort-2/3), cranial vault, and basal skull fractures had much higher risks of an accompanying intracranial hemorrhage. Pan-facial maxillofacial fractures (OR 19.1) and high-energy injuries (OR 50.8) increased the risk of an accompanying intracranial hemorrhage. Nevertheless, traumatic intracranial hemorrhages were seen with one simple fracture of the zygoma, one of the maxilla, two fractures of the mandible, and even two maxillary alveolar fractures. Four patients (23.5%) had to undergo neurosurgery to decompress an intracranial hematoma. High-energy injuries may affect the intracranial vessels, leading to hemorrhage in different intracranial compartments. Therefore, when treating maxillofacial fractures, oral and maxillofacial surgeons and emergency and critical care physicians should always consider the clinical signs of traumatic intracranial hemorrhage, in close consultation with critical care centers and neurosurgeons.

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Introductions

Patients with craniomaxillofacial fractures may have accompanying traumatic intracranial injuries¹⁻³. The leading cause of morbidity and mortality in head trauma patients is a traumatic intracranial hematoma¹⁻⁴. A clinical review reported that the frequency of neurological injury associated with facial fractures is as high as 76% and that localized injuries to the face and head resulting in maxillofacial fractures might also involve the brain and meninges⁴⁻⁵. While most patients with minor head injuries with or without maxillofacial trauma usually recover quickly, some deteriorate, necessitating intervention for an intracranial hematoma²⁻⁵. A study demonstrated that 2.8% of facial fracture patients who are conscious with a Glasgow Coma Scale (GCS) score of 15 in the absence of clinical neurological abnormalities have an accompanying intracranial hematoma²⁻⁴⁻⁶. However, the relationship between maxillofacial fractures and intracranial hemorrhage remains to be clarified. Prompt detection and a neurosurgery consultation may improve the outcome of head injury⁵⁻⁶.

In general hospitals, computed tomography (CT) is now performed routinely for patients with impaired consciousness or neurological signs such as vomiting, nausea, and
seizures. By contrast, although patients with severe pan-
facial fractures are probably expected to be subject to head
CT screening, patients with a maxillofacial trauma/jaw
fracture only, such as with trauma to the alveolus or man-
dible, are often screened and diagnosed using plain radi-
ographs. Consequently, any accompanying traumatic intracra-
nial hemorrhage is discovered only after clinical deter-
riation of the patient, with the development of seizures, vom-
iting, and nausea. Although CT is expensive and
involves high radiation exposure, data indicate that its se-
lective use could reduce healthcare costs.

This study sought to identify maxillofacial fracture pat-
terns predisposing patients to intracranial hemorrhage.
Occasionally a patient with minor maxillofacial trauma
requires neurosurgical intervention, which prompted us
to calculate the risk for accompanying intracranial hem-
orrhages in maxillofacial fracture patients. These data may
enable the more efficient use of CT, thereby improving
the treatment of maxillofacial fractures by oral and maxil-
lofacial and trauma surgeons at emergency and critical care
centers.

Patients and Methods

The medical records of patients with maxillofacial frac-
tures treated at the Division of Oral and Maxillofacial
Surgery (OMS) of Kagawa Prefectural Central Hospital,
Kagawa, Japan between January 2005 and June 2008 were
reviewed. The patients had been deemed to have a
crianio-maxillofacial fracture based on CT or plain radiographs; an initial head CT had been performed in
patients with impaired consciousness; neurological signs
such as vomiting, nausea, and seizures; or clinical signs
of basal skull or cranial vault fractures. Fractures in the
LeFort categories had been evaluated in the zygomatic or
nasal-maxillary complex group, as these bones were in-
volved. Pan-facial fractures were those with more than two
cranio-maniiofacial bone fractures. Brain injuries such as
intracranial hemorrhage had been diagnosed by experi-
enced neurosurgeons following clinical inspection and had
been treated immediately after their detection, as war-
ranted.

The patients’ age, gender, route to visit the hospital,
cause, type, and location of craniomaxillofacial fractures,
and neurological injuries were analyzed.

Statistics

The statistical analysis included a descriptive analysis,
developed chronic subdural hematomas after treatment of the initial maxillofacial fracture. The first was treated with transcranial drainage through a burr hole and the second was followed carefully by neurosurgeons. Table 2a lists the clearly defined locations of the maxillofacial fractures related to traumatic intracranial hemorrhage. Of the 26 panfacial fracture patients, 11 (42.3%) suffered from intracranial hemorrhage. All six cranial vault fractures and all five basal skull fractures had accompanying intracranial hemorrhages, as did five (83.3%) of the six patients with a severe mid-face LeFort-2 or -3 fracture. In the multivariate logistic regression model, pan-facial maxillofacial/jaw fracture (odds ratio (OR) 19.1) was the strongest independent predictor of intracranial bleeding in maxillofacial fracture patients (Table 3a). Nevertheless, traumatic intracranial hemorrhages were seen in one simple fracture of the zygoma (7.1%), one of the maxilla (14.3%), two fractures of the mandible (3.3%), and even two maxillary alveolar fractures (2.5%) (OR 0.16), although these ORs were not significant as independent predictors of the risk for maxillofacial trauma accompanying intracranial bleeding, except for alveolar fractures (Table 3a).

As shown in Table 3b, 13 (76.5%) of the 17 patients with intracranial hemorrhages had been involved in traffic accidents, which was a significant risk factor (OR 4.06), three were in falls (17.6%), and one was in a workplace accident (5.9%). For these three categories of maxillofacial trauma, the logistic regression model further revealed that by far the most significant risk factor for intracranial hemorrhage was high-energy injuries (OR 50.8).

Overall, four of the 17 intracranial hemorrhage patients (23.5%) needed to undergo emergency neurosurgical decompression by neurosurgeons.

**Discussion**

High-energy trauma that breaks craniomaxillofacial-facial bones can result in the rupture of intracranial vessels, leading to intracranial hemorrhage in different compartments, as described previously, and as reflected in the incidence of hemorrhages following traffic accidents reported here. The injuries accompanying maxillofacial trauma can be a greater threat to life than the fractures themselves. In addition, a study reported that the presence of an intracranial hemorrhage was associated with a poor survival. Therefore, in our hospital, as soon as we identify an intracranial hemorrhage related to maxillofacial trauma, we con-
Table 3. Independent predictors of intracranial hemorrhage in patients with maxillofacial fractures.

<table>
<thead>
<tr>
<th></th>
<th>%</th>
<th>OR</th>
<th>OR 95% CI</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pan-Facial</td>
<td>42.3</td>
<td>19.1</td>
<td>6.18-58.85</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>(Cranial vault fracture)</td>
<td>(6) / (6)</td>
<td>(100)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Basal skull fracture)</td>
<td>(5) / (5)</td>
<td>(100)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(LeFort II and/or III)</td>
<td>(5) / (6)</td>
<td>(83.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zygoma</td>
<td>7.1</td>
<td>0.76</td>
<td>0.09-6.19</td>
<td>&gt;0.9999</td>
</tr>
<tr>
<td>Maxilla</td>
<td>14.3</td>
<td>1.72</td>
<td>0.19-15.18</td>
<td>0.491</td>
</tr>
<tr>
<td>Mandible</td>
<td>3.3</td>
<td>0.26</td>
<td>0.06-1.16</td>
<td>0.099</td>
</tr>
<tr>
<td>Alveolus</td>
<td>2.5</td>
<td>0.16</td>
<td>0.04-0.76</td>
<td>0.009</td>
</tr>
</tbody>
</table>

OR: odds ratio, CI: confidence interval

sult with neurosurgeons. Overall, the number of patients requiring neurosurgical decompression of an intracranial hemorrhage was comparatively low and was similar to the number in a previous study. 2-4,6. Four patients (23.5% of all intracranial hemorrhage or 2.1% of all 188 maxillofacial fracture patients) underwent neurosurgery for decompression. In most cases, simple clinical signs such as seizures, vomiting, nausea, headache, and a history of a closed head injury suggested an intracranial hemorrhage, and we performed screening head CT. Often, these early considerations allowed us to detect patients at elevated risk for an intracranial hemorrhage. Based on our series and previous similar studies, cranial vault and basal skull fractures are the strongest predictors of intracranial bleeding, as are severe midface fractures. 1-3, 6, 11. A previous study demonstrated that head trauma presenting with facial injuries can sometimes mask traumatic intracranial hemorrhage until clinical deterioration occurs.6 Therefore, it is crucial to consider traumatic intracranial hemorrhage ensuing from the initial trauma as a possibility, as about 9% of all maxillofacial fracture patients sustain an intracranial hemorrhage requiring immediate neurosurgical intervention, as suggested in this study (Table 2). Moreover, the risk is greater with panfacial fractures associated with high-energy trauma. This study used a multivariable logistic regression model to verify and identify pan-facial maxillofacial/jaw fractures (OR 19.1) and high-energy injury (OR 50.8) as the strongest independent predictors of intracranial bleeding in facial fractures patients, which until now was, at best, an empirical, unproved assumption (Table 3).

Surprisingly, our series revealed that trauma causing simple single fractures of the maxilla, zygoma, or even the maxillary alveoli could cause an intracranial hemorrhage (Table 2a). Two patients who had sustained mandibular fractures after falling on asphalt developed intracranial hemorrhages and required close neurological observation in the hospital. This could be, in part, because the tolerance of the mid-face, maxilla, nose, and zygoma to energy forces is lower than that of the frontal and mandibular bones, as reported in a biomechanical study. 6, 11. Although most of our cases had clinical signs of intracranial hemorrhage, including seizures, vomiting, nausea, and headache, we should carefully observe the maxillofacial fracture patient in hospital, or warn them or their family of the possibility of an intracranial hemorrhage if they prefer to go home against advice.

In the last decade, some clinical studies have identified high-risk findings that clearly indicated which groups of patients with head injuries should undergo head CT. 12-15. They reported a 3 to 19% incidence of a positive head CT in those patient groups, and the need for neurosurgical intervention was 0.08 to 3.3%, similar to our findings. 1-6, 12-15. Some clinical reviews have concluded that patients with minor head and facial injuries and a normal neurological examination could be discharged home safely 14, 16, 17. Nevertheless, 2.8% of 2,195 craniomaxillofacial fracture pa-
tients with a presenting GCS score of 15 following minor head trauma had an intracranial hemorrhage requiring neurosurgery 1). Overall, in patients with a history of loss of conscious or amnesia, but with no nausea, vomiting, headache, dizziness, or signs of depressed skull vault fractures, routine head CT may have a minimal effect on trauma management and may not be warranted 12-18).

It remains difficult to identify clear indications for routine head CT for screening maxillofacial fracture patients for intracranial hemorrhage. Nevertheless, this study clearly suggested that routine head CT screening be required for maxillofacial trauma patients with high-energy injuries or pan-facial maxillofacial/jaw fractures, as high-risk indicators. Maxillofacial trauma surgeons and the trauma team should consider an intracranial hemorrhage as accompanying maxillofacial fractures from the initial admission and should not neglect a screening examination that includes head CT and neurological consultation, in order to diagnose intracranial hemorrhage immediately. Our goal is to avoid the discharge of a craniomaxillofacial fracture patient, even a patient with a small maxillofacial fracture, from the emergency department, with an undiagnosed intracranial hemorrhage.

References

顔顱面骨骨折における頭蓋内出血の合併損傷

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要旨 顔顱面外傷においては、頭蓋内損傷を合併することがあり、早期の精査及び診断が予後に直結し重要である。今回我々は、顔顱面骨骨折患者における頭蓋内出血の合併損傷について、そのリスクをretrospectiveに検討を行った。対象は2003年1月から2008年6月までの3年6か月間に香川県立中央病院歯科口腔外科にて加療を行った顔顱面骨骨折を有する188例（男性119名、女性69名、平均年齢40.0歳）について診療録、X線撮影記録を用い評価を行った。合併頭蓋内損傷については脳神経外科にて診断、加療がなされた。17例（9.0％）の顔顱面骨骨折患者に頭蓋内出血の合併を認め、内訳は顔内12例（6.4％）、脳膜下9例（4.8％）、硬膜下7例（3.7％）、硬膜外1例（0.5％）であった。中顔面骨骨折（LeFort-2/3）、顔顱骨骨折、顔蓋底骨折においてはリスクが高く、高頻度で顔蓋内出血の合併を来していた。一方、重症度の低い、単独での顔骨骨折、上顎骨骨折、下顎骨骨折や上顎歯槽骨骨折においても顔蓋内出血の合併が認められた。顔蓋内出血を合併した17例中4例（23.5％）において血腫除去術が施行された。とくに顔顱面多発骨折（OR 19.1）、高エネルギー外傷（OR 50.8）による顔顱外傷に顔蓋内出血を合併するリスクが有意に高く、顔顱CT撮影による評価が必須であることが示唆された。したがって、顔顱顔外傷治療にあたっては、顔蓋内損傷、顔顱内出血合併の可能性を考慮し、評価・診断にあたることが重要であると考えられた。

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