Penetration of the mandibular condyle into the middle cranial fossa: report of a case in a 6-year-old girl

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Reported cases of dislocation of the mandibular condyle into the middle cranial fossa are rare. Treatment of this injury should be individualized and should take in account the age of the patient, growth potential, the degree of glenoid fossa destruction, the risk of ankylosis and the risk of further cranial injury. In children, functional therapy is aimed at helping the restoration of posterior facial height, good occlusal relations and function. Long-term follow-up is mandatory. Surgery may be required later to correct asymmetrical growth or developing ankylosis. This article describes a case of condylar penetration into the middle cranial fossa in a six-year-old child and the treatment performed to minimize consequences on occlusion and facial development.
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INTRODUCTION

Condylar injuries following trauma to the mandible are relatively common and generally result in condylar neck fractures or anterior dislocations; superior dislocations in the middle cranial fossa are rare.[1] The versatility of the protective mechanism against fossa penetration is enormous. Anatomically the craniofacial structures are adequately designed to absorb impacts resulting from facial trauma. The thin condylar necks, the buttering of the base of skull and the absorption of forces by the posterior occlusion are some of the factors able to dissipate energy and to prevent the penetration of the condyles in the cranial base. Articular surfaces of the condylar heads may be another important factor in force dissipation. In fact the lateral and medial areas of the condylar head rest upon the thicker portions of the middle cranial fossa and provide a larger surface area to absorb the impact. The thicker portions of the middle cranial fossa table act as a buttress to further dilute severe trauma and vector the forces. The medial and lateral elevated margins of the glenoid fossa normally meet the articular surface of the condyle on impact, thus protecting the central weak area.[2] Besides, in cases of trauma to the mandible resulting in a superior movement, the posterior teeth should normally occlude and block the upward thrust of the jaw[3] even if there is evidence in literature that the posterior teeth may or may not be a deterrent to vertical displacement.[4]

There is an equal sex distribution in reported injuries of this kind with a wide age variation.[5] It may be that traumatic lesions of this type are more frequent than those reported in literature. However, survival of the patient may be affected by concomitant, severe, neurological damages: epidural and subdural hematomas may occur,[6,7] as well as facial paralysis in case of fracture of the cranial base.[3,8,9] Other possible immediate complications include significant brain injury,[3,9] dural tear with leakage of cerebrospinal fluid, and decreased hearing caused by eighth cranial nerve damage.[3,6,9]

Treatment of reported cases vary widely[10] and may include craniotomy, subcondral osteotomy with interpositional graft, condylectomy, various types of elastic traction and condylotomy, leaving the impacted condyle in the cranial fossa.[8,9,11-14] Most of the treatments are successful in that postoperative function is acceptable with no further neurological problem.[3]

A case of unilateral traumatic TMJ dislocation in the middle cranial fossa is reported so that others may evaluate it and possibly benefit from our experience.

CASE REPORT

A healthy 6-year-old girl was referred for clinical and radiological examination following a serious facial trauma. There was a history of a maxillo-facial operation occurred seven months before following a blunt trauma to the point of her chin after an accidental fall while playing. At the time of the initial injury, the

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Figure 1. The scar resulting from a blunt trauma to the point of the chin.

patient had been seen in a local emergency room. On first examination a 2cm laceration was present at the inferior symphysis (Figure 1.) with severe restriction in jaw movements, marked deviation of the mouth to the left and alteration in occlusion. The parents denied loss of consciousness, facial numbness or respiratory difficulty.

Physical examination showed intact facial nerve function and limited mouth opening with no lateral excursion. The mandible, maxilla, orbits and nose as well as the dentition, were intact to inspection and palpation.

Bleeding from the soft tissue injuries was minimal and there was no sensory disturbance about the face. Results of neurological, abdominal, thoracic and orthopedic examinations were within normal limits.

Radiographic examination consisted of plain facial radiographs including left and right lateral oblique, postero-anterior and panoramic views of the mandible and lateral and postero-anterior views of the face. The panoramic radiograph showed the absence of the left condyle in the glenoid fossa. There was no condylar neck fractures or evidence of zygomatic, nasal, orbital or maxillary fractures. An axial computed tomography (CT) scan demonstrated no facial or cranial fractures, but views of the mandibular condyles showed a marked asymmetry of the vertical position due to a superior condylar impaction on the left (Figure 2). Glenoid fossa comminute fractures were evident with no fracture of the left condyle. No other bony injuries were identified. Coronal reconstruction confirmed the diagnosis. The patient was referred for further evaluation and hospitalized for definitive treatment consisting in arch bar application and elastic intermaxillary fixation.

The arch bars were removed ten days after. During the following seven months the girl began experiencing a moderate developing facial asymmetry with lateral deviation during mouth opening and progressive, but evident reduction in opening movements.

Figure 2. CT scan of the patient showing the asymmetrical vertical position of the mandibular condyles due to the intracranial impaction on the left.

Figure 3. Frontal photograph: a moderate, developing facial asymmetry is evident.

At this time, the parents sought a second opinion. On that occasion an evident facial asymmetry was noted on the left side (Figure 3), no hearing deficiency was apparent, vision was not impaired and neurological findings of the cranial nerves were unremarkable. There was a reduction in mouth opening to 21 mm with an evident deviation to the left side (Figure 4). Lateral excursions were almost totally absent.

Figure 4. Frontal photographs showing an evident reduction in mouth opening with a marked deviation to the left.

On palpation the mandibular left condyle could not be felt.

The intraoral examination confirmed the presence of a bilateral first molar class with a lateral mandibular shift of 7mm; the upper and lower dentoalveolar midlines were not coincident. On closed position a cross bite on the left side was observed (Figure 5).

The new CT scan showed the persistent asymmetry of vertical position of the mandibular condyles confirming the deep penetration of the left one into the middle cranial fossa. The right mandibular fossa appeared intact (Figure 6).

A neurosurgeon was consulted and he concluded that primary neurosurgical intervention was indicated to reposition the condyle and to restore the integrity of the glenoid fossa. During the operation the left temporal and preauricular areas were prepared to allow access to the temporomandibular joint (Figure 7). The TMJ disc was completely destroyed, the condyle was slightly irregular, but intact, with no evidence of fracture, and strongly adherent to the contiguous tissues. The glenoid fossa was markedly comminuted, but the articular eminence was intact.

The condyle was then mobilized with success. To restore the integrity of the glenoid fossa and the vertical position of the condyle, a bone reconstruction was performed. The disk was completely disrupted because of the intracranial impaction. It was substituted by a goretex membrane. The occlusion was assessed and found to be stable, in spite of the presence of a cross bite on the left upper arch. During the postoperative follow-up, antibiotics were given, but no infective complication occurred. During the following weeks, facial asymmetry improved, but reduction in mouth opening and deviation were still very apparent.

Figure 5. Intraoral view: the upper and lower dentoalveolar midlines are not coincident; a lateral mandibular shift is evident

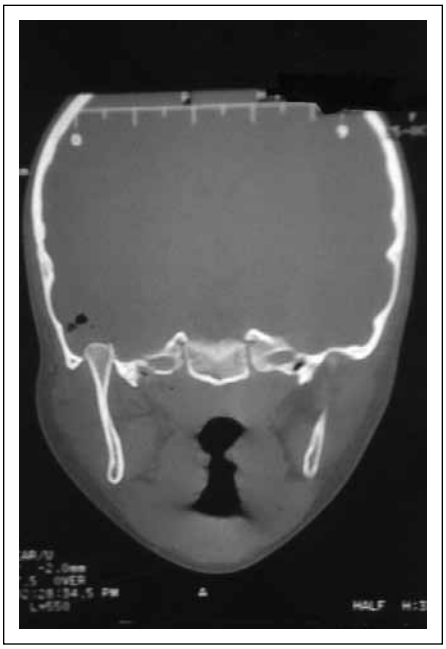


Figure 6. CT scan seven months after the first operation. There is a persisting asymmetry of condylar vertical position confirming persistent, deep, intracranial position of the left one.

The patient was thus immediately scheduled for a functional appliance therapy to help restoration of proper mastication and growth. After one month, mouth opening was improved to 29 mm and a reduction in deviation to 5.5 mm to the left during opening movements was observed. The progressive correction of the left cross bite helped a lot in the repositioning of the mandible.

Three months after the beginning of the functional treatment the clinical examination showed an evident improvement in facial asymmetry, mouth openings and deviation (Figures 8, 9). The panoramic radiograph

Figure 7. The scar of the preauricular incision to gain access into the middle cranial fossa.

(Figures 10, 11) and the postero-anterior cephalometric projection (Figure 12) showed a moderate decrease in vertical height on the left side of the mandible. The CT scan showed more clearly the remodeling of the left condyle after the bone reconstruction (Figures 13-15).

The girl is still in treatment and shall be followed during growth to check facial development and occlusion. Periodical clinical and radiological evaluations will be performed.

Figures 8-9. Frontal photographs taken one month after the beginning of functional appliance therapy. There is an improvement in facial asymmetry and mouth opening and a reduction in deviation.

Figures 10-11. The panoramic radiograph taken three months after the beginning of functional therapy. The remodeling of the left condyle is evident (arrows).

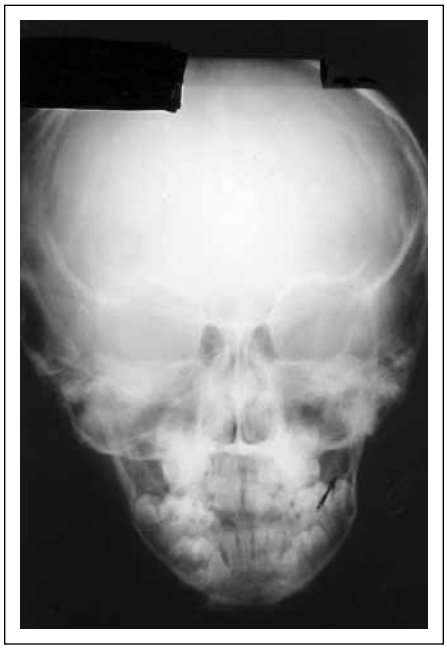
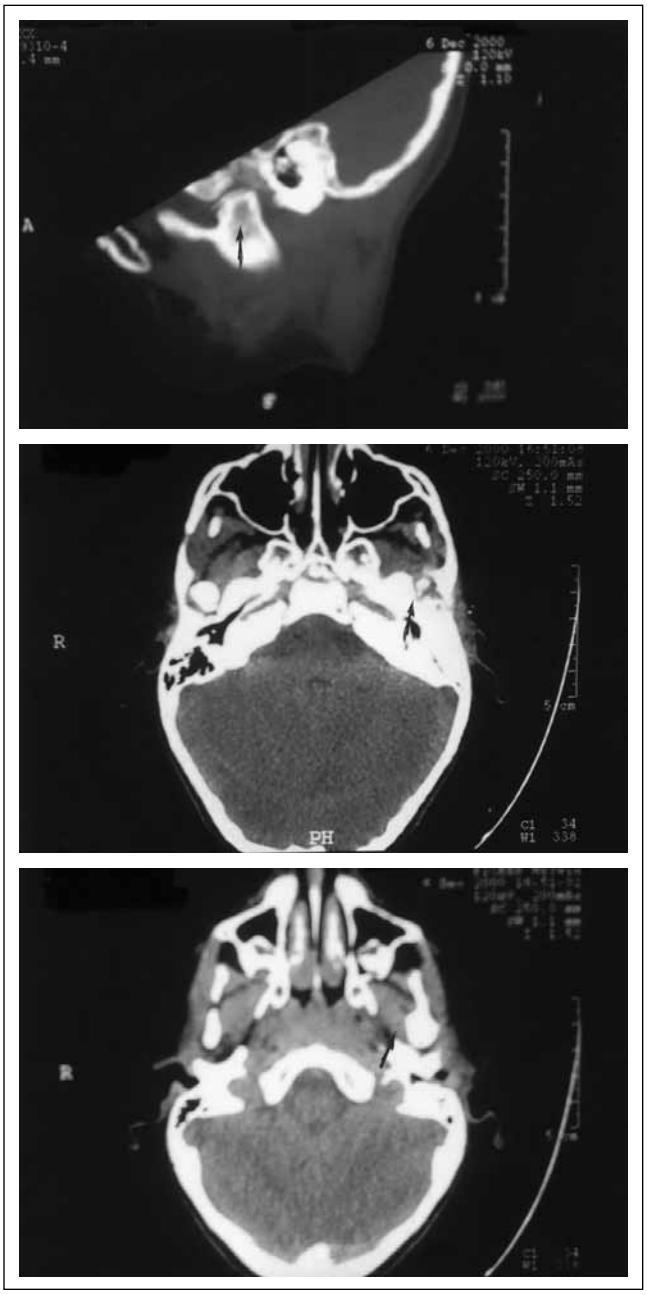


Figure 12. The postero-anterior cephalometric projection showing the mandibular asymmetry with an undeveloped ramus on the left side resulting in a moderate decrease in vertical height (arrows).



Figures 13-15. CT scan of the patient showing an evident remodeling of the left condyle in different reconstruction (arrows).

DISCUSSION

When making the decision for treatment, certain factors should be carefully considered. The neurological status of the patient and concomitant neurological injuries determine the urgency with which reduction of the dislocation should be accomplished. Neurosurgical consultation is mandatory in all cases. The presence of intracranial bleeding, subdural or epidural hematoma, dural tear, or bony fragments embedded in brain tissue must be determined preoperatively. The treatment of these conditions is largely the responsibility of the neurosurgeon. Concomitant basilar skull fractures may complicate the reduction. They may even be worsened by attempts at condylar reduction. Communicating wound may predispose to infection and possibly lead to meningitis. These conditions will influence the decision as to the use of a closed or open technique. The proximity of the fracture to the middle meningeal artery and the branches of the posterior cerebral artery will also influence the choice of treatment and may necessitate a craniotomy approach.[4]

In this case, closed reduction was unsuccessful in spite of the evidence of the literature, which emphasizes how this is the approach to be primarily considered for patients diagnosed and treated early as this is the least invasive treatment.[11] It has a history of success. Beyond two to four weeks enough early healing has occurred to render closed reduction ineffective or unstable. For fractures treated beyond this initial healing period, an open technique is probably most appropriate.[15,16]

In this patient, a chin trauma was involved with no fracture of the condyle on the penetration side and no lesion on the other side. The asymmetrical position of the two condyles was responsible of the rise of the mandible on the left with consequent shift of the chin towards the injured side. This resulted in a change in the relations between the dental arches with an evident facial asymmetry. Besides, all the movements of the mandible were altered, mouth opening was remarkably reduced and a marked deviation to the left appeared. Lateral movements were severely limited and a cross bite on the side of injury was observed like often

reported in literature.[12] This situation was complicated by the deep intracranial dislocation of the left condyle and the long persistence (7 months) in the middle cranial fossa. This led to adhesion between the articulating parts of the TMJ and the surrounding tissues: the scarring process resulted in reduction of joint mobility and chin deviation to the affected side during mouth opening with persistent limitation of motion and serious consequences on facial development.

After the first operation, the persisting clinical abnormalities, i.e. laterognathism, lateral deviation during opening movements, reduction in mouth opening, limitation of lateral movements of the jaw, decreased mandibular mobility, advised a different type of surgical approach.

The functional treatment planned after the second operation was aimed at reducing the consequences of the trauma with rapid restoration of functional movements of the jaw and good occlusal relations. In fact in the acute postoperative phase the reduction of mobility is partly due to pain on movements and partly to the obstruction offered by the edema and the effusion in the joint space. In this stage, mobilization of the TMJ is very important and the use of functional appliance therapy, is an easy way to perform continuous exercises, to keep the mandible in a good position and to avoid unbalanced loading on both joints. The mobilization of tissues within and around the joint affords comfort, while hematomas are releasing and tissues are recovering, frees restraints of fibroses components and the lateral eminence, increases TMJ mobility and reduces load concentration. Furthermore it provides stimulation to the muscles within the painful limits, washes away the metabolites resulting from the muscle spasm and helps the mandible to keep normal position while moving.[17,18] This should help a "functional" regeneration of the articulating surfaces and may improve condylar remodeling.[19]

Attention must also be given to occlusion in order to favor restoration of a proper function of the masticatory system.[19] The progressive orthodontic correction of the left cross-bite, first probably due to the anomalous intracranial position of the left condyle and then stabilized by growth, helped a lot the repositioning of the mandible.

SUMMARY

There have been only a few case reports of condylar impaction into the middle cranial fossa. Severe trauma to the glenoid fossa is usually prevented by fracture of the condylar neck, which presumably acts as a safety mechanism. Condylar heads and necks are designed to withstand unconventional forces. Therefore injuries to the mandible are transmitted to the symphysis, body or angle. This usually result in ipsilateral or contralateral fractures to the side of impact or in fracture of one or both condylar necks.[20] In this way the penetration in the cranial fossa is unlikely to occur. Besides the anatomy of the fossa, condyle and condylar neck presumably accounts for the rarity of this event. The medial portion of the fossa is thin relative to the thicker lateral one, which is supported by the zygoma and the temporal bone[12,21] whereas, the condylar neck is relatively thin in contrast to the broad head.

Condylar dislocation is frequent coincidental with excessive force in conjunction with directed muscular contraction and may be related to the direction of the trauma, abnormalities of condylar morphology or presence of a particular thin roof of the glenoid fossa. Therefore, forces are vectored and dissipated either by the disk, or the contiguous muscles or the osseous structures acting as a single entity or in a combination, thereby making fossa perforation unlikely.[6,15]

The fact that the mouth is wide open at the exact moment of the trauma is important, as well as lack of posterior occlusion also has been suggested to be a predisposing factor to condylar penetration in the cranial base.[21] In this situation a trauma to the chin may result in a blow with sufficient angulation to drive the condyle through the glenoid fossa. Other predisposing factors reported by literature include a small, rounded condyle, which fails to occlude on the fossa margins,[12,22,23] lack of posterior teeth or increased pneumatization of the temporal bone.[12,24,25]

Based on literature, an attempt at manual closed reduction / condylar extrication with arch bar placement and maxillomandibular fixation or elastic traction seems warranted for early injuries.[24] Concomitant presence of fractures of the neck of the condyloid process may make closed reduction impossible. If manual extrication is not possible, an open procedure should be planned after neurosurgical consultation.

The extent of damage to the roof of the glenoid fossa should be assessed. Severity of displacement of the fragments will influence the rate of healing as well as the decision of whether an inter-positional implant or bony graft is necessary to prevent relapse. The duration of maxillomandibular fixation will also vary with the need for stability and the prevention of ankylosis.

Age of the patient, size and shape of the condyle and malleability of the bones are factors that influence the difficulty of reduction and the likehood of success with closed methods. Growth potential of the condylar area and influence of associated structures must be carefully considered when treating children.

Severe injuries may be followed by ostinate or irreversibile sequelae such as interference with jaw movements and growth disturbances. In this case, hemorrhagic effusion in the reconstructed joint space might be followed by cicatricial contractions, adhesion between joint component and even by fibrous or bony ankylosis. Other predisposing factors for ankylosis are prolonged immobilization, damage to the disc and infection.[4] Postoperative antibiotic therapy is always

mandatory to avoid secondary infections and further complication during the phase of recovery. In children in fact, such lesions may result in damage to the condylar growing area causing interference with jaw movements and leading to anomalies and malocclusion.

Considering these factors, there is certainly a possibility of ankylosis occurring in the case reported in view of the young age at presentation, radiographic evidence of serious articular damage and the fact that the disk has been completely destroyed. Radiographic evidence of progressive resorption of the articular surface of the condyle in the long term has occurred in other cases.[5,12,26]

Late complications are possible, so long-term follow-up is mandatory to assess bony changes in the joint, occlusion, and development of ankylosis. Disturbance of mandibular growth are more likely when the injury occurs in the under 10-year group. In fact, at this age deformity is not self correcting, and there is no way to compensate for the loss or retarded growth. Any traumatism affecting the condyle will alter the normal progression of function and consequently harmony of development of facial structures resulting in some type of TMJ and/or mandibular deformity. Condylar growth retardation with morphological changes from excessive force on the developing condyle head has been reported in literature.[17,27] An early therapeutic treatment is therefore essential in limiting these types of consequences.[17]

Review is necessary and surgery may be required later to correct any asymmetrical growth or developing ankylosis.

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