Treatment of condylar fractures in children and youths: the clinical value of the occlusal plane orientation and correlation with facial development (case reports)

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The relative position of the plane of occlusion to the cranial base determines the direction of the forces generated in the cranium during occlusal function. When the plane of occlusion is level and when the neuromuscular system is in harmony, the vectors of forces created by the closing muscles are directed to the central area of the cranium in a symmetrically balanced way. Unfortunately, TMJ fractures may alter completely this balance with loss of the support to the mandible against the temporal component and loss of the functional effect of the lateral pterygoid muscle on the mandible. Changes in orientation of the occlusal plane may result in facial alteration and asymmetries. In our experience, the restoration of a plan of occlusion orthogonally aligned to the forces of occlusion for a correct transfer of forces through the maxilla to the rest of the cranial bones is essential to allow proper face development. Two, quite similar cases of unilateral, dislocated condylar fracture treated in a different way, will be reported to demonstrate how this can occur. Available clinical data will be illustrated.
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INTRODUCTION

For the cranio-facial-dental complex to function properly, teeth, jaws, masticatory muscles and cranial bones must be in harmony with each other. The net forces transferred to the occlusion (teeth, periodontal ligaments, bones, mucosa) are dependent on the forces created by the contraction of the closing muscles and on the position of the plane of occlusion relative to the reference horizontal.

The maxillae, mandible and dental occlusion are considered parts of the postural alignment of the skeletal system. A change in any of them must be proportionately matched by appropriate growth changes and adjustment to sustain and progressively achieve functional and structural balance of the whole.[1] The relative position of the plane of occlusion to the cranial base determines the direction of the forces generated in the cranium during occlusal function: the vectors of forces created by the closing muscles (mainly the masseter, the medial pterygoid and the temporalis muscles) are directed to the central area of the cranium in a symmetrically balanced way. [2]

The integrity and interaction of bony and soft-tissue structures, which form the TMJ, may be highly disturbed by condylar fractures. They are generally associated with a more or less severe damage to the capsule and disk. Large, adaptive changes may occur in both the fractured and the contralateral condyle. As a result, disturbance of mandibular growth and TMJ dysfunction may occur depending on the age of the patient and the fracture site.[3-5] Furthermore, in cases of TMJ fractures the mechanical restrictions created by scarring and loss of motion may cause morphological alterations of the condylar shape[6,7] with modification on the dynamics and alterations in muscular activity. Sutherland in early 1900s theorized that trauma and myofacial tension can cause disruption to osseous craniofacial relationship.[9]

If the position of the body of the mandible changes, there is a concomitant change in the position of the condyles in the TM joints. The deviation of the plane of occlusion from a parallel relationship to the reference horizontal, will cause excessive and unbalanced occlusal forces in the system with consequential pathological results affecting teeth, periodontal ligaments, bone, mucosa, cranium, facial muscles, neck, shoulders, and the rest of the body. The stabilisation of this condition may result in facial alteration and asymmetries.[8]

The aim of this article is to demonstrate how this can occur and the different results obtained with dif-

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Figure 1. Frontal photograph: the lesion resulting from the trauma to the point of the boy's chin is evident

ferent treatments. Two, quite similar cases of unilateral, dislocated condylar fracture both treated with closed reduction combined with functional appliance therapy will be reported. Clinical data will be illustrated.

CASE REPORTS

CASE 1

A healthy six-year-old boy was referred to by his pediatrician for clinical and radiological examination following facial trauma. He had fallen off his bike hitting his chin.

The clinical examination showed a reduction in mouth opening (to 24 mm) with a shift of the chin towards the right side (Figure 1) and limitations in lateral excursions. The gentle palpation of the area of the right condyle gave rise to crepitation and pain.

The intraoral examination showed a remarkable open bite and the boy felt a change in occlusion after the trauma (Figures 2 to 4). Laterodeviation to the right during mouth opening was evident. A panoramic radiography, a postero-anterior cephalometric projection and a tomography were performed. They showed a unilateral, medially dislocated fracture of the right condylar neck (Figures 5 to 7).

The patient was treated with a conservative method: a liquid diet and antiphlogistic drugs were recommended for one week to mitigate symptoms. The insertion of a relieving, stabilizing splint was decided to support the mandible against the temporal components. The splint was removed after one week to avoid adhesion between the articulating parts. The patient was immediately scheduled for a functional appliance therapy. After eight months of functional treatment no developing facial asymmetry is present, mouth opening is 40mm, the occlusal plane is flat (Figures 8 to 10) and a marked reduction of the anterior open bite is evident (Figures 11 to 13). Radiographic examinations (Figures 14, 15) and the MR scan (Figure 16) show the remodelling of the fractured condyle. The functional unit of the disk and the condyle is preserved. The boy is still in treatment.

Figures 2-4. Intraoral view at the first visit after the trauma with a remarkable open bite and alteration in posterior occlusal relationship is evident.

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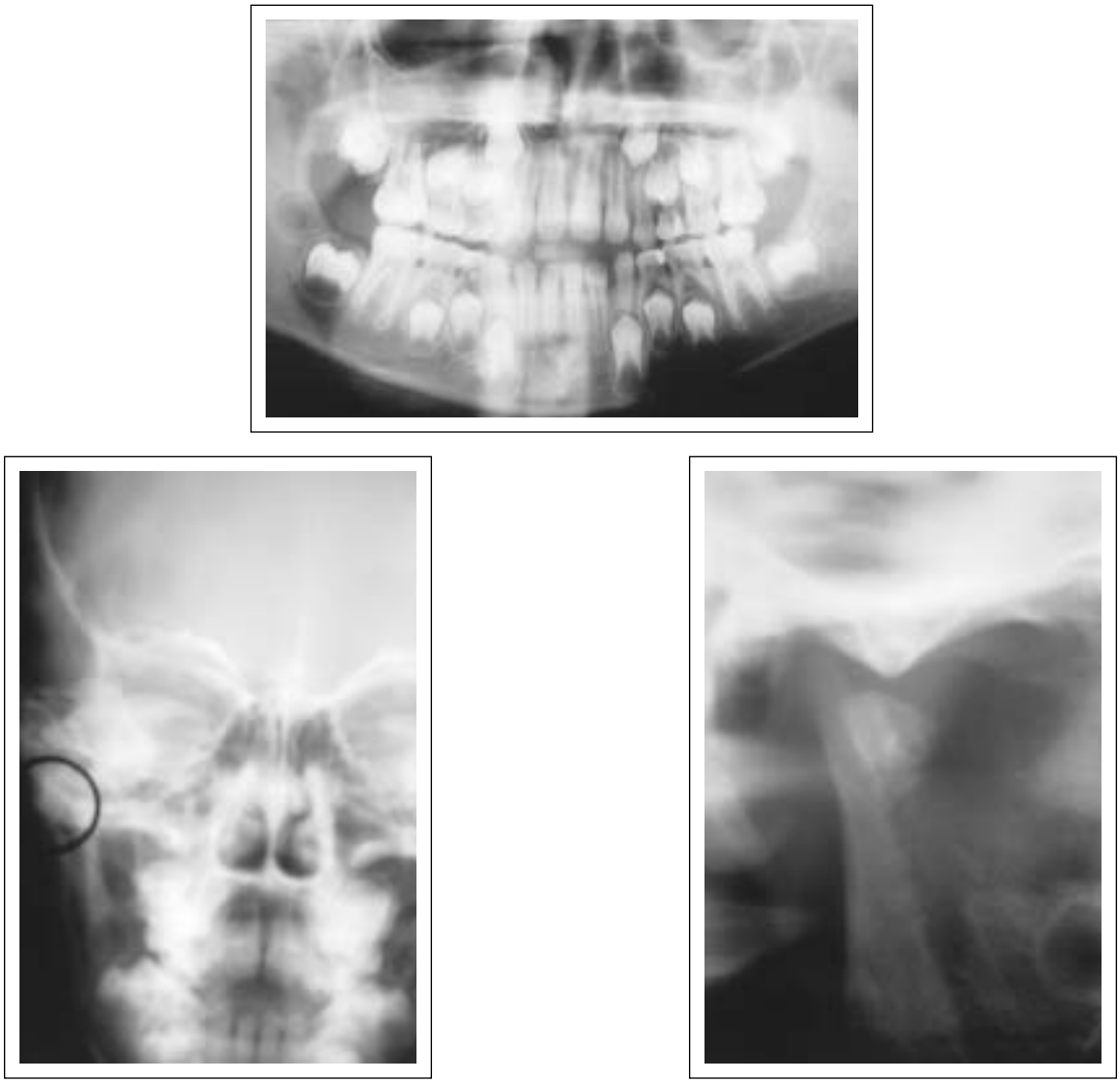

Figures 5-7. The panoramic radiograph, the postero-anterior cephalometric projection and the tomography show a medially dislocated fracture of the right condyle (arrows).

CASE 2

A healthy six-year-old boy was referred to by his pediatrician for an examination because of a developing facial asymmetry. The mother stated that the asymmetry had become more evident during the last year. She reported that gestation and delivery of the child had been uneventful. Delivery had been vaginal and with no forceps being used. There was a history of trauma to the mandible, which occurred at the age of three resulting from a bike fall. On that occasion the boy cut his chin and was brought to his pediatrician, but as he apparently had a relatively minor pain without any disturbances to other structures, i.e. neither dental nor, facial, no radiographic examination was performed. The slowly developing facial asymmetry went unnoticed for three years and then suddenly was perceived as a problem.

The clinical examination disclosed a facial asymmetry due to a deficiency on the right side, with some apparent effect on adjacent areas of the maxilla. A shift of the chin (5mm) towards the right side during mouth opening was evident (Figure 17, 18). Opening movements were within normal limits with a limitation in both protrusive (5mm) and lateral excursions, particularly on the left (3mm). The intraoral examination showed a mixed-dentition stage, with a developing second class malocclusion and a marked misalignment of the occlusal plane relative to the reference horizontal.

The panoramic radiograph showed a medially dislocated condyle on the right with an undeveloped ramus (Figure 19). The TC scan exhibited more clearly the medial angulation of the fractured right condylar neck. Remodelling of the right condylar fossa and a more flat condyle as compared to the left one, was evident (Figure 20).

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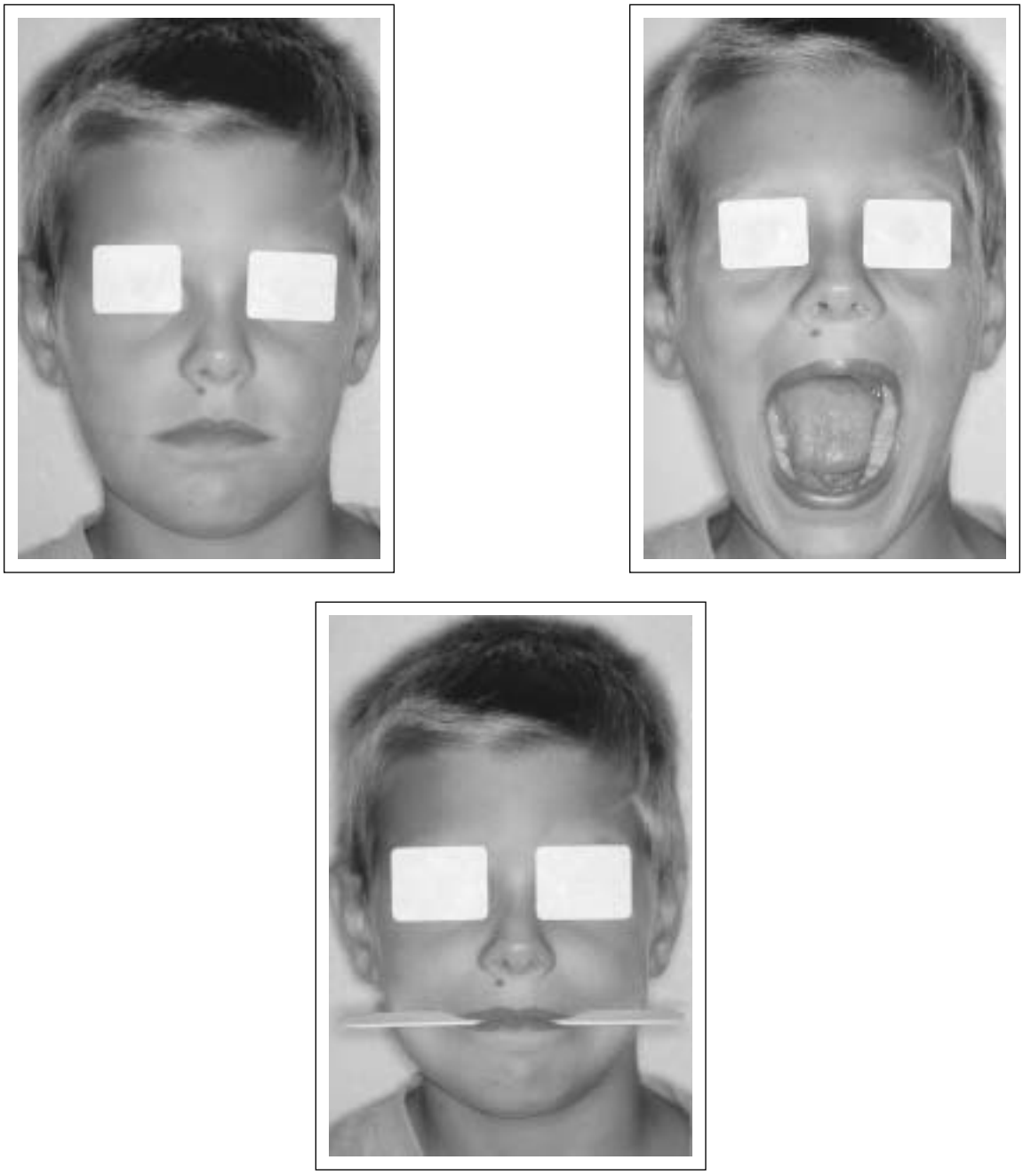

Figures 8-10. Frontal photograph taken eight months after the beginning of functional appliance therapy. There is no developing facial asymmetry, no laterodeviation during mouth opening and the occlusal plane is flat.

The patient was scheduled for an approach with a functional appliance, but a year after the beginning of the treatment, the postero-anterior cephalometric projection put in evidence an undeveloped ramus on the right side resulting in a moderate decrease in vertical height and mandibular asymmetry. The misalignment of the occlusal plane was evident. The boy is still under observation.

DISCUSSION

There are two possible causes of a growth deficiency following injuries to the condyle: a loss of stimulus to normal growth and a growth deficiency due to the mechanical restrictions created by scarring and loss of motion. The persistent dysfunction can also lead to decease in the joint secondary to the changes in functional load with morphological alterations of condylar and articulating surfaces.[10]

In the first case described the use of a functional appliance immediately after the trauma offered comfort, while hematomas were resolving and tissues were recovering and allowed the mandible to keep a proper relation to the maxilla and provide continuous stimulat-

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Figures 11-13. Intraoral view eight months after the beginning of functional appliance therapy. A marked reduction of the anterior open bite is evident and the occlusal plane is flat.

Figures 14-15. The panoramic radiograph and the postero-anterior cephalometric projection taken eight months after the beginning of functional appliance therapy. The remodelling of the right condyle is evident and the occlusal plane is flat.

ing function. This treatment aims at providing stimulation to the muscles within the painful limits and at washing away the metabolites resulting from the muscle spasm. The mobilisation of tissues within and around the joint frees restraints of fibroses capsular components and the lateral eminence, increases disk mobility and reduces load concentration.[11,12] Results after eight months from the beginning of the therapeutic treatment are very encouraging. There is a marked reduction of the open bite, mouth opening has increased from 24 to 40 mm and the occlusal plane is flat.

With regards to the growth and adaptive requirements for the mandible, it is not just the condyle that participates, but the whole ramus is directely involved. It is the ramus that places the mandibular arch in occlusal relation and position with the maxilla. Its dimensions and morphology are directly involved in the attachment of the masticatory muscles and it must accommodate their growth and size. These observations support the idea that the amount of skeletal growth of the face is strongly connected to a function equally balanced on both sides[13-16] and regulated by the

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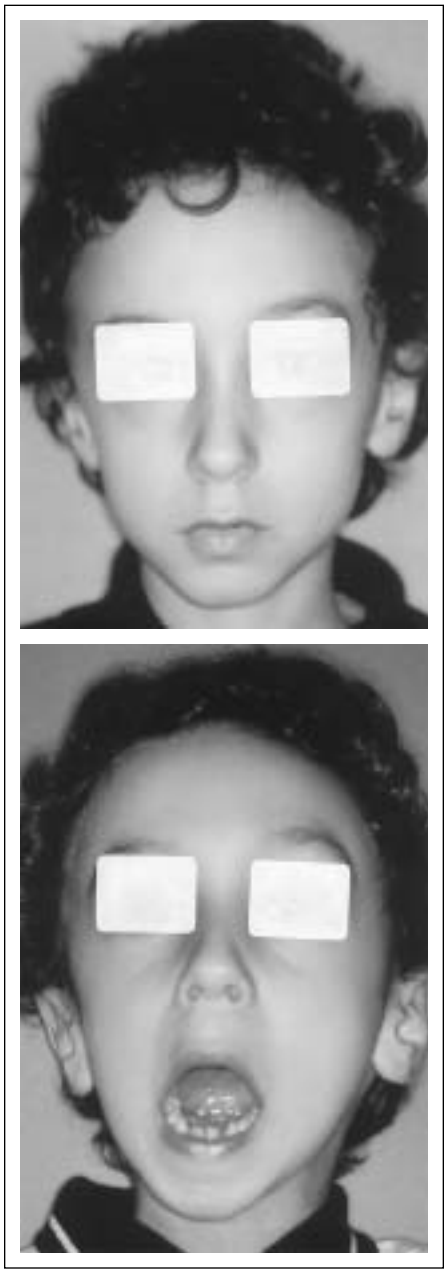
Figure 16. RM scan eight months after the beginning of functional appliance therapy showing the remodelling of the right fractured condyle. The functional unit of the disk and the condyle is preserved bilaterally.

functional activation of muscles.[17] This patient shows a good orientation of the occlusal plane with no deviation of the chin during mouth opening and no developmental facial asymmetry. MR scan show a moderate remodelling of the right fractured condyle, with a correct relation with the disk at rest and during mouth opening. The functional unit is preserved bilaterally.

In the second patient the consequences of the trauma became evident three years later, when the child began to develop a facial asymmetry because of a lack of growth on the injured side. The spontaneous healing of the displaced TMJ fracture lead to a functional ankylosis, which resulted in mandibular deformity and alteration of related structures. An ankylosis-like effect on growth is possible, even though the mandible is able to move. A restriction to translate the mandible forward out of the fossa, with functional limitations of the movement, is the main cause. When opening is restricted to only a hinge type of movement, a progressive growth deficiency is often observed.

Skeletal manipulation may so result in alteration in the degree of TMJ loading, which ends in unbalanced loading with additional stress to one or both joints.

One year after the beginning of the functional treatment, the clinical parameters for mandibular functional evaluation are almost the same (deviation of the midline during mouthopening: 4mm; protrusive excursions: 5mm; lateral excursion: 3mm). The postero-anterior cephalometric projection shows a decreased vertical height of the mandible on the right with an undeveloped ramus and a change in orientation of the occlusal plane confirming the persistent dysplastic pattern of growth.



Figures 17-18. Frontal photograph showing a developing facial asymmetry with a shift of the chin towards the right side during mouth opening.

This case clearly shows how results of functional appliance therapy after consolidation of mandibular dysfunction and facial maldevelopment are disappointing: in these cases, even though the deformity may not be progressive, it is not self correcting and there is no way to compensate for the loss or retarded growth.[18]

The occlusal function suffers constant changes during development and is one of the most important of the oral functions related to growth. That is why the preservation of a good position of the plane of occlusion relative to the reference horizontal is essential.

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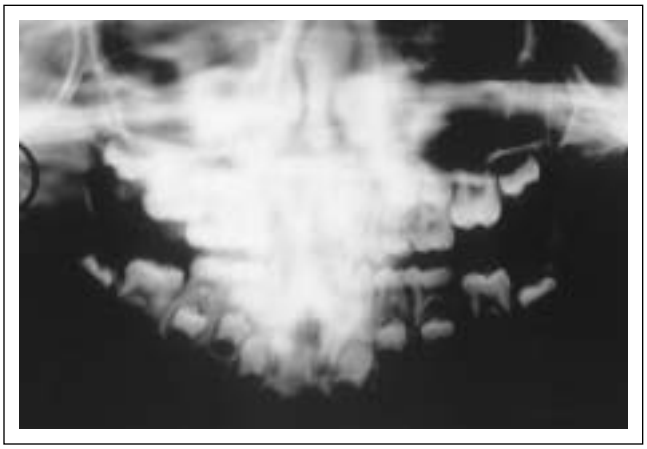

Figure 19. The panoramic radiograph showing the remodelling of the right condyle with an undeveloped ramus on the right side.

Figure 20. TC scan of the patient. The medial angulation of the condyle due to a previous undiagnosed fracture and the remodelling of the right condylar fossa (more flat when compared to the other one) are evident.

When the plane of occlusion is level and the mandible, articular disk, and head of the condyles are in good position, plus the neuromuscolar system is in harmony, the loading of forces on the TM joints is optimal and balanced. It is a normal condition for the TM joints to be loaded. The constant tension of the muscles of mastication on the mandible makes this so. The movements of the mandible are automatic and the patterns are engraved in the memory of neuromuscolar mechanism. They obey a reflex command and are in synchrony with the movements of the tongue. The swallowing reflex brings the maxillary and mandibular teeth into contact and the tongue is raised to the hard palate. The vertical forces generated are trasmitted via the palatine, maxillae and vomer to the sphenoid.[2] Furthermore, the muscle tension of the TM joint forces the head of the condyles against the articular disks and slope of the articular eminences. In this way the forces created within the TM joints and transmitted to the temporal bones and to the rest of the cranium are balanced.

Unfortunately, TMJ fractures can alter completely this balance with loss of the support to the mandible against the temporal component and loss of the functional effect of the lateral pterygoid muscle on the mandible. Particularly, unilateral, displaced fractures cause a shift of the chin towards the injured side and a rise of the mandible of the same side. This results in a change in the relation between the dental arches including supra-contact between the molars on the fractured side and rotation of the occlusal plane.

Disturbances in the harmonious interplay of the masticatory muscles cause further deviation of the mandible towards the affected side when the patient opens his mouth wide, as well as limitation of lateral excursions towards the unaffected side.[19]

When the plane of occlusion is misaligned, the vectors of forces will be misdirected away from the cranial base resulting in a pathological condition. In this way,

Figure 21. The postero-anterior cephalometric projection one year after the beginning of functional appliance therapy. The misalignment of the occlusal plan is evident.

the distorted plane of occlusion can be a contributing factor in side-bending, rotation and torsion of the sphenobasilar synchondrosis. The main consequence is that TMJ loading becomes unbalanced in spite of optimal positions of the articular disks and head of the condyles.

The forces transmitted to the temporal bones and to the rest of the cranium become unbalanced and this can be a major factor in creating an externally rotated temporal bone on the low side and internally rotated temporal bone on the high one with disharmony in the neuromuscolar system causing muscle tension on the cranial attachment points and abnor-

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mal forces in the mechanism. Unequal vertical forces generated on the teeth and hard palate during swallowing and chewing, are not transmitted to the sphenobasilar synchondrosis, but are greater on the lower side. This phenomena occurs because the muscles of the high side lose strength due to chronic hypertonicity. The unequal force vectors affects adversely an optimal sphenobasilar flexion by inhibiting the amplitude of motion. The consequence may be a deformation of the cranium and development of facial asymmetries.[2]

The aims of the treatment of TMJ fractures are bony union of the fragments to restore proper size, shape, and position of the maxillae, mandible and plane of occlusion as parts of the postural alignment of the skeletal system. In our experience, the restoration of a plane of occlusion orthogonally aligned to the forces of occlusion for a correct transfer of forces through the maxilla to the rest of the cranial bones is essential to prevent or minimize facial maldevelopment.

Mariano Rocabado, a leading physical therapist in treating TMJ and related diseases, stated: " If any of the three horizontal planes (the bipupilary, the otic and the the occlusal plane) are not horizontal, adaptative position will be made over the time by the rest of the spinal column to restore the planes to level. The drive to level these three planes is so strong that if the bipupilary and the occlusal plane are not parallel and horizontal, a gradual warping of the face will occur, resulting in facial asymmetry."[20] So the proper alignment of the three planes - the bipupilary plane (representative of the sphenoid bone), the otic plane (a land mark of temporal one) and the occlusal plane is necessary for success.

CONCLUSION

It is logical to assume that because of the nature of interdigitation of the sutures, if these two head bones move, so would the others.[21] This is our main goal in treatment, no matter which type of functional appliance is used, to achieve this result, as any alteration in this orientation ends in unbalanced loading of articular and muscular structures with serious repercussions on facial development. The orthostatic balance of the cranium and the cervical spine is best maintained when the occlusal, the otic and the bipupillary planes are kept parallel. If the plane of occlusion is distorted or altered, certain neuromuscolar activity can occur and cause postural adaptation to maintain orthostatic balance. Postural adaptation can end in biomechanical dysfunction in head, neck and shoulders resulting in the side-bending of the cranium with rotations in the cervical vertebra. Long-term follow-up of these patients are critical to monitor for any sign of TMJ dysfunction and growth abnormalities.

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