Feature

# Cranial Strains and Malocclusion:
## A Rationale for a New Diagnostic and Treatment Approach

*This article has been peer reviewed.*

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In our last article[1] we described the external features which characterize the cranial and facial structures of the cranial strains known as hyperflexion and hyperextension. To understand how these strains develop we have to examine the anatomical relations underlying all cranial patterns. Each strain represent a variation on a theme. By studying the features in common, it is possible to account for the facial and dental consequences of these variations.

The key is the spheno-basilar symphysis and the displacements which can take place between the occiput and the sphenoid at that suture. In hyperflexion there is shortening of the cranium in an antero-posterior direction with a subsequent upward buckling of the spheno-basilar symphysis (Figure 1). In children, where the cartilage of the joint has not ossified, a v-shaped wedge can be seen occasionally on the lateral skull radiograph (Figure 2).

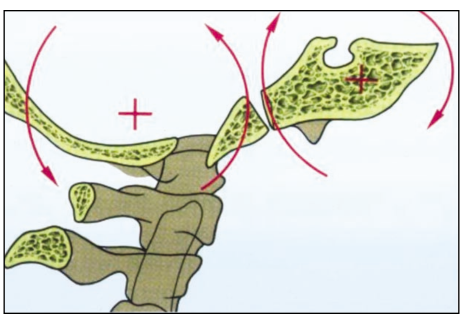
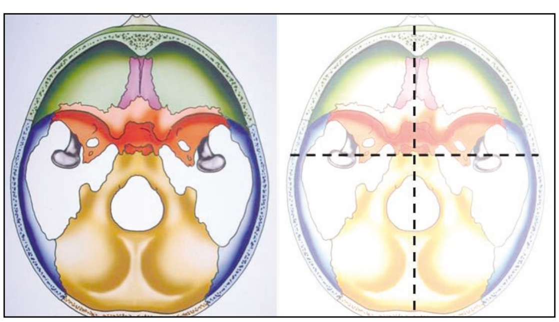


Figure 1. Movement of Occiput and Sphenold in Hyperflexion. Reprinted from *Orthopedic Gnathology*, Hockel, J., Ed. 1983. With permission from Quintessence Publishing Co.

Figure 2. Lateral Skull Radiograph of Hyperflexion patient. Note V-shaped wedge at superior border of the spheno-basillar symphysis.

Figure (3a) is of the cranial base seen from a vertex viewpoint. By leaving out the temporal bones the connection between the centrally placed spheno-basilar symphysis and the peripheral structures of the cranium can be seen more easily. Sutherland[2] realized that the cranium could be divided into quadrants (Figure 3b) centered on the spheno-basilar symphysis and that what happens in each quadrant is directly influenced by the spheno-basilar symphysis. He noted that accompanying the vertical changes at the symphysis there are various lateral displacements. As the peripheral structures move laterally, this is known as external rotation. If they move closer to the midline, this is called internal rotation. It is not unusual to have one side of the face externally rotated and the other side internally rotated (Figure 4a). This can have a significant effect in the mouth, giving rise to asymmetries (Figure 4b). This shows a palatal view of the maxilla with the left posterior dentition externally rotated and the right buccal posterior segment internally rotated, reflecting the internal rotation of the whole right side of the face. This can be seen in hyperflexion but also other strains.

With this background, it is now appropriate to examine in detail the cranial strain known as hyperflexion. As its name implies, it is brought about by an exaggeration of the flexion/ extension movement of the cranium into flexion. Rhythmic movement of the cranium continues despite the displacement into flexion, but it does so more readily into flexion than extension. As the skull is shortened in an antero-posterior plane, it is widened laterally.



Figures 3a and 3b. 3a: cranial base from a vertex view (temporal bones left out). 3b: Sutherland's quadrants imposed on cranial base.

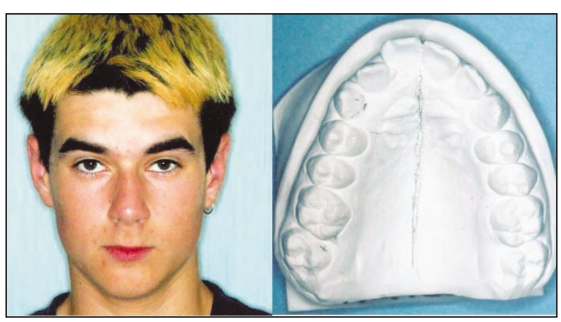


Figure 4a and 4b. 4a: Patient with right side of face internally rotated. 4b: View of maxillary arch with right side internally rotated.

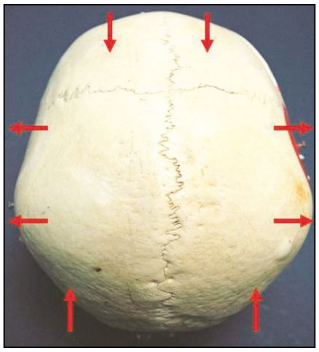


Figure 5. Vertex view of Hyperflexion skull. Note A-P shortening and lateral expansion.

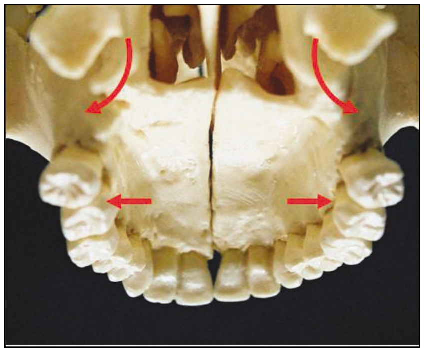


Figure 6. Palatal displacement in Hyperflexion.

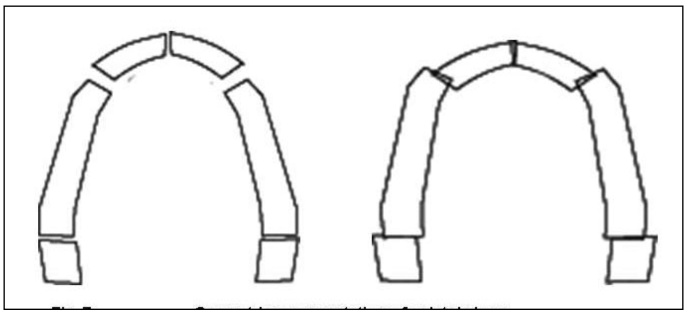


Figure 7. Geometric representation of palatal shape — "normal" (left) compared to "hyperflexion" (right). Diagrams reproduced with permission from Dr. Darick Nordstrom.

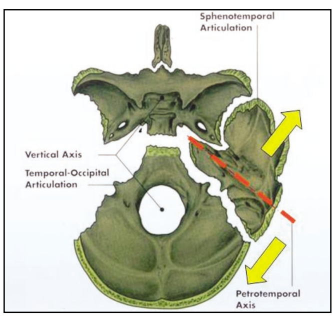



Figure 8. Vertex view of cranial base showing axis of rotation of temporal bone. Adapted from *Orthopedic Gnathology,* Hockel, J., Ed. 1983. With permission from Quintessence Publishing Co.

This widening occurs in both the anterior and posterior quadrants of the skull. All four quadrants are therefore said to be in external rotation. Figure 5 shows a vertex view of a hyperflexion skull.

The effect of the external rotation on the two anterior quadrants of the cranium is to give the flatter cranial outline, wide eyes, wide nares and malar processes already identified as characteristic of hyperflexion (Figure 9a). Dentally, the palate is widened and flattens (Figure 6). The premaxillary component is deflected palatally as the cranium shortens (Figure 7). The whole maxilla may be displaced distally as well as the premaxilla. The combination results most frequently in an Angle Class II, Division ii malocculsion as the mandible is also distally placed.

When we examine the two posterior quadrants in a hyperflexion case, there is an apparent contradiction. As the occiput rotates around a horizontal axis (Figure 1), the skull shortens. This would seem to move the glenoid fossae forward, causing a tendency to mandibular prognathism as Enlow et al[3] theorized. Obviously, this does not happen. In fact, the fossae move distally carrying the mandible with them. The explanation for this paradox is the axis of rotation around which the temporal bone rotates (Figure 8). This is diagonal to the midline. The axis runs from the external auditory meatus to the tip of the petrous portion of the temporal bone. As the spheno-basilar symphysis is elevated into hyperflexion carrying the petrous tip with it, the lateral component of the temporal bone (the squamous or vertical plate) flares laterally, but due to the angle of rotation it also goes forward. On the other hand the glenoid fossae move distally as well as mesially. This explains the link between flaring of the ears and a distal movement of the mandible.

The tendency to carry the mandible distally is compounded by the deep overbite. This limits forward development of the mandible and may be associated with the lingual inclination of the mandibular dentition, both the anterior and posterior teeth. However, there are several occlusal variations within the hyperflexion pattern, which will now be discussed.

This is the individual seen in the previous article (Figures 9a, b, c). Note again the facial pattern with this. The dentition is that of a classical Class II, Division ii malocclusion with lingual displacement of the mandibular first bicuspids. There is a deep overbite and the maxillary central incisors are significantly retroclined. The first phase of treatment was with an Advanced Lightwire Functional (A.L.F.) appliance, then a twin bloc and straight wire fixed appliance.

This patient (Figures 10a, b, c) has a definite resemblance to the previous patient but in this case all four maxil-

Figure 9a. Hyperflexion — full face and profile characteristics.

Figure 9b. Class II Division malocclusion.

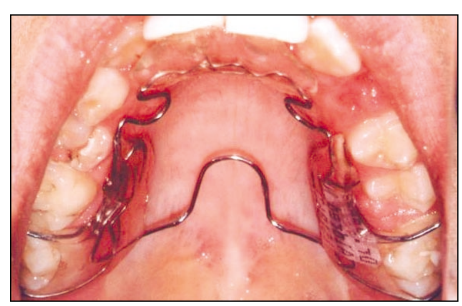


Figure 9c. Initial maxillary A.L.F. appliance used for patient 9a, b.

Figure 10a. Hyperflexion — full face and profile.

Figure 10b. Variation on Class II Division II — All maxillary incisors are retroclined.

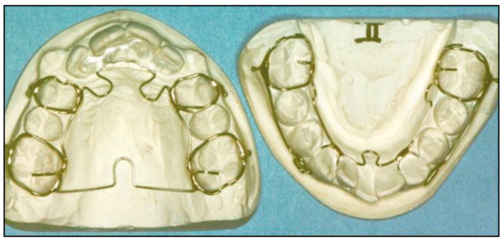


Figure 10c. Maxillary and mandibular A.L.F. appliances used for patient 10a, b.

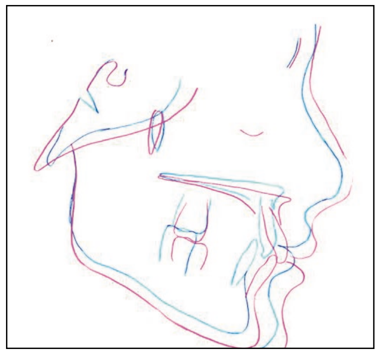


Figure 10d. Pre- and post-treatment tracings of patient 10a, b.

Figure 11a. Hyperflexion patient with Angle Class I occlusion.

Figure 11b. Angle Class I occlusion with retro-positioned maxilla.

Figure 11c. Initial A.L.F. appliances used or patient 11a, b.

lary incisors are retroclined. This is a common variation. The cuspids are displaced buccally with almost complete lack of space. This patient, age 13 years, has already experienced some temporomandibular joint signs and symptoms due to distal placement of the condyles in their fossae.

This patient (Figure 11a, b, c) has an obviously obtuse nasolabial angle, but the dentition in fact is an almost ideal Angle Class I with a slightly reduced overbite and overjet. In conventional orthodontic terms it could be call a bi-maxillary retrusion. The key again is the distal placement of the maxilla and the facial characteristics that go with this. This patient's symptoms included temporomandibular joint pain, otalgia, tinnitus and headaches. There was severe restriction of mandibular movement due to temporomandibular joint dysfunction. The treatment objective was to release the hyperflexion cranial pattern which was the primary etiological factor. This was accomplished by A.L.F. appliances (Figure 11c), plus Class III elastics and a reverse pull facemask. Occlusal pads were used to decompress the joints and protect them from the effect of the Class III elastics. Subsequent to maxillary advancement the A.L.F. appliances were converted to a twin bloc and fixed appliances were used for final alignment.

## Radiographic Evidence of Hyperflexion

Before discussing actual measurements, examination of the lateral skull radiographs can be revealing. Since the occiput rotates upwards and forwards at the basilar position, it carries the occipital condyles forward and with them the C1 vertebra. At times there may be loss of the primary curvature of the cervical vertebrae (known as a military spine) or even a reverse curvature of those vertebrae (Figure 12). There can be compression of the transverse processes of C1 vertebra against the occiput.

The cranial base angle, strictly speaking, is measured as Nasion-Sella-Basion but Basion can be hard to locate. Hopkin et al used Na-S-Ar4 (Figure 13). Articulare is a radiographic construct where the posterior border of the vertical ramus crosses the basi occiput. In practice Na-S-Ar is really a measurement of the antero-posterior position of the glenoid fossae. This suits very well since it is the glenoid fossae position which is of interest. Using a sample of 630 patients, classified on the basis of the dental relationships, Hoplin et al found that their averages for the Na-S-Ar were Class III=122°, Class I=124°, Class II, Division II=126.5° and Class II, Division I=128°. This shows the tendency for the angle to open, thus carrying the glenoid fossae and the mandible distally.

Another quite effective way to identify the a-p position of the maxilla and the mandible relative to the cranium is by extending perpendiculars from Na, Point A and Point B onto the Frankfort Plane (Figure 14). Point A, on average, should be one or ±2 mm away from Na. Point B should lie 6 mm behind Na. This is a quick means of assessing a-p relationships and can be easily incorporated into most other cephalometric analyses. It is important to remember that Point A will move distally if maxillary incisors are proclined during treatment.

Another important point is that not every hyperflexion shows a high cranial base angle or a retruded maxilla. Radiographic evidence is very useful but it is essential to combine it with other records. A standing postural examination; full face, profile and postural photographs, a thorough myofascial and temporomandibular joint examination and articulator mounted models mounted with a functional generated occlusal record are needed as well as the dental examination. All the evidence is utilized to make a diagnosis. This is a much more elaborate process than is generally practiced, but it enables a far more precise individual assessment to be made. The result is a more profound understanding of the patient's total stomatognathic system and its relation to the body as a whole. Diagnosis can not be fully achieved using hand held models and a lateral skull radiograph.

Obviously, treatment has to be planned to meet the particular variation within the hyperflexion pattern, but certain broad principles can be outlined.

The primary concern is to counteract the a-p compression of the skull, which characterizes the hyperflexion patient. The first objective is therefore to establish the maxilla in a correct position relative to the cranial base. In practice, this may mean advancing the maxilla itself where it is distally placed. Class III elastics, or if needed, a reverse pull facemask may be used as illustrated in the treatment of the latter two patients (Figures 10a, 11a). In order for the premaxilla to be advanced, lateral development of the buccal segments may also be required.

Once the maxilla and the maxillary arch are correctly positioned relative to the cranium, consideration has to be given to the position of the mandible. The mandibular arch itself has to be aligned. Downward and forward movement of the mandible will often start spontaneously as the maxilla is freed up. Particular care is taken of the temporomandibular joints. The combination of correct positioning of the maxilla and mandibular development brings about a more physiological balance through the whole musculo-skeletal system and in particular in the temporomandibular joints.

The levels of forced used, with an appreciation of the cranial concept, are very much lighter than current practice. The aim is to synchronize with or enhance the cranial rhythm, not overwhelm it or depress it. The maximum genetic potential of growth can only be achieved by freeing up the cranial restriction.

The second patient (Figures 10a, b, c) demonstrates the importance of this. He had already been seen by an orthodontist who had recommended extraction of maxillary first bicuspids because of the severe crowding, then fixed appliances to align the maxillary and mandibular arches and reduce the deep overbite. This conventional orthodontic approach could lead to an acceptable result in dental terms. From a functional aspect it would probably have resulted in worsening of the temporomandibular joint dysfunction already present. Both maxillary and mandibular development would be severely restricted.

A functional orthodontic treatment might have considered extraction of second molars and distalization of buccal segments in the maxilla while advancing the labial segment. This would certainly be preferable to the previous treatment plan but still falls short of what could be achieved.

The actual treatment was non-extractive. The initial appliance was an Advanced Lightwire Functional appliance. The premaxilla was advanced while bringing the whole maxilla forward as well. As the A.L.F. appliance was being worn, Class III elastics and a reverse pull facemask were employed to advance the maxilla.

The aim was that by advancing the maxilla the pterygoid processes would be tipped forward. This in turn would rotate the sphenoid in an anti-clockwise direction thus counteracting the effect of the hyperflexion (Figure 1) i.e. correcting the cranial strain. Once an adequate increase of overjet was established, the A.L.F. appliances were converted to a twin bloc appliance to develop the mandible, then fixed appliances were used for final positioning. Figure 10d

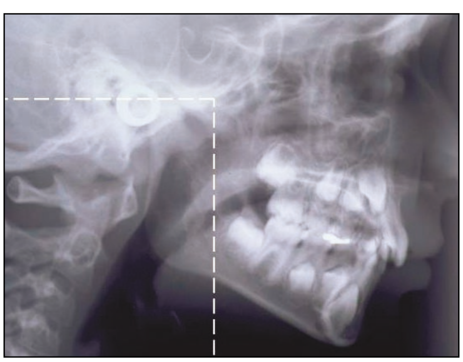


Figure 12. Lateral skull radiograph showing loss of primary cervical curvature in Hyperflexion case.

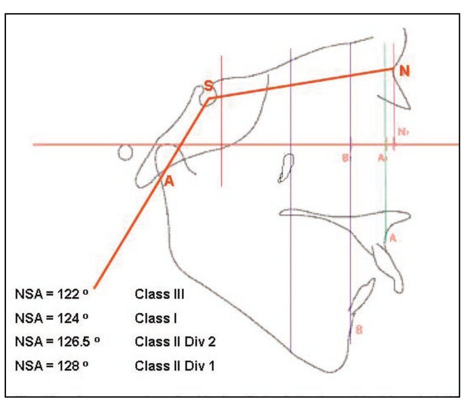



Figure 13. Average values for Naesion-Sella-Articulare — Hopkins et. al. 1968.

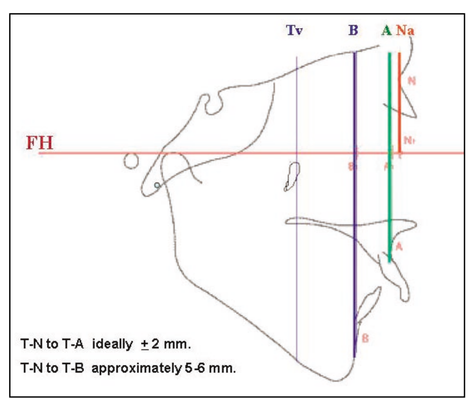



Figure 14. Projection onto Fankfort plane for Nassion, point A and point B Described by Dr. Jim Jecmen (seminar May 1996).

shows pre and post treatment tracings superimposed. The extent of forward movement of point A is significant especially since maxillary incisors were proclined. The amount of mandibular development is also obvious.

It is our contention that by identifying the cranial strain and directing treatment primarily to compensate for the strain, we can harness a powerful corrective force, which has not been recognized or utilized until now. That is the self-correcting mechanism inherent in living systems.

This hypothesis will be developed in subsequent articles.

## References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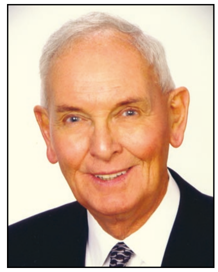

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