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## The Hyoid Bone as a Point of Mechanical Convergence

### 1. Anatomy and connections

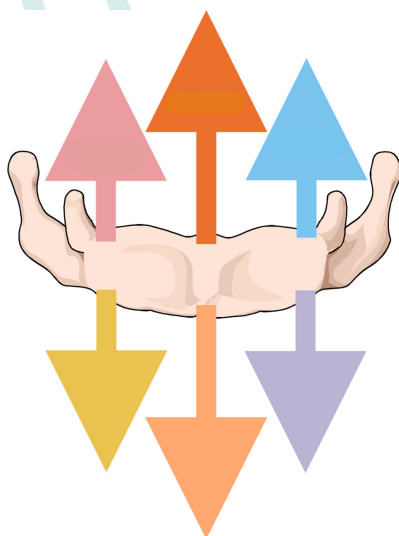
The hyoid bone represents a particular case in this biomechanical analysis: it is completely suspended in the anterior region of the neck, maintained in position exclusively through a complex system of muscular and fascial connections.

This condition of total suspension makes the hyoid bone a distinctive anatomical element.

Unlike the skeletal structures examined so far, in which joints provide precise mechanical constraints, the position of the hyoid bone in space is determined solely by the balance of the muscular forces converging on it.

This anatomical characteristic produces several biomechanical consequences: the hyoid bone becomes the point of mechanical convergence of six muscular systems arising from the cranium, mandible, sternum, scapula, larynx, and pharynx.

Through these connections, the hyoid bone participates as a passive element in complex functions: it is mobilized during mandibular opening, during swallowing and phonation, follows respiratory movements, and adapts to changes in cranio-cervical axes and scapular position.



*Figure 1 - Geniohyoid, mylohyoid: green; stylohyoid: blue; sternohyoid: light blue; digastric (anterior and posterior bellies): red; omohyoid: magenta*

### 2. The hyoid bone as a point of force convergence

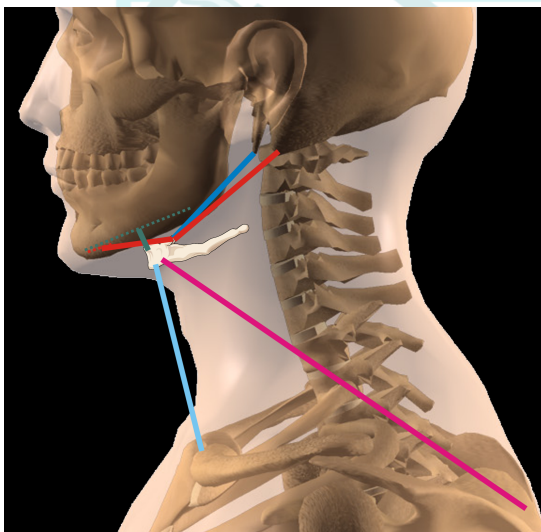
The hyoid bone lies at the centre of a system of muscular forces arising from the cranium, mandible, sternum, and scapula, and its position in space is determined by the vector balance of all these converging forces.

When tension changes in any of the inserted muscles, through shortening of the connective tissue components according to the mechanisms analysed in Chapter 2, the balance of forces is altered and the bone is passively displaced into a new position.

This displacement induces the other muscles of the system to increase their tone in order to adapt to the new geometry, and since they are connected to other skeletal regions, tension alterations propagate to the cranium, mandible, cervical vertebrae, and scapula.

This is not an active transmission: the hyoid bone passively undergoes the action of the applied forces, and its new position determines the mechanical conditions for redistribution of tensions throughout the entire region.

Because of this mechanical characteristic, it can be considered a nodal point of the cranio-cervico-scapular system.



*Figure 2 - Geniohyoid, mylohyoid: green; stylohyoid: blue; sternohyoid: light blue; digastric (anterior and posterior bellies): red; omohyoid: magenta*

It is important to emphasize that the hyoid bone does not exert any regulatory action or autonomous functional role: every positional variation is the passive resultant of the balance of the muscular forces converging on it.

## 2.1 Systemic integration

The muscles inserting on the hyoid bone are part of the muscular system that functionally connects the cranium, cervical spine, thorax, and pelvis.

When tension changes in one region, it propagates mechanically through the anatomical connections.

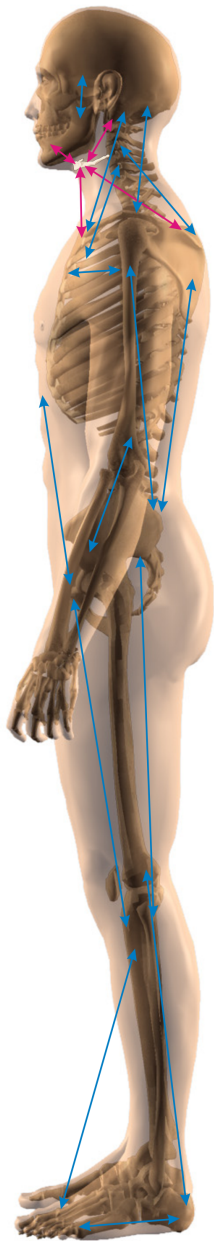
The hyoid bone functions as a mechanical relay: it neither generates nor amplifies signals, but represents the point through which tension changes are redistributed.

As in an electrical relay, where variation in one circuit influences the connected circuits, so tension modifications reaching the hyoid bone through one muscular group determine mechanical variations in all the other inserted muscles.

From the scapula and sternum, muscles arise that are directed cranially toward the cervical vertebrae and the cranium, and caudally toward the thoraco-lumbar vertebrae and the pelvis.

Through its direct and indirect connections, the hyoid bone participates in this network of force distribution.

A tension arising from the scapular region may therefore mechanically influence the mandibular region, and vice versa.



*Figure 3 - In the achievement of static and dynamic goals, muscular connections with the hyoid bone (magenta arrows) influence and are influenced by the muscular connections of the other body regions (blue arrows). The hyoid bone thus becomes a mechanical relay interposed between the cranium and the underlying body regions.*

### **3. Force analysis: dominance of the suprahyoid muscles**

Vector analysis of the hyoid system shows clear dominance of the suprahyoid muscles over the infrahyoid muscles: the digastrics, stylohyoids, geniohyoids, and mylohyoids are more numerous and present stronger force vectors.

Moreover, their force lines have more favourable angulations for traction in the cranial and anterior direction.

The infrahyoid muscles—sternohyoid, omohyoid, thyrohyoid—are subdominant.

Their ability to oppose upward traction is limited both by their smaller number and by their less favourable vector arrangement.

When excessive tensions develop in any region connected to the hyoid bone, the dominance of the suprahyoids produces elevation and anterior displacement of the bone, with the anterior belly of the digastric playing the prevailing role.

If tension in the omohyoid is asymmetrical, lateral deviation may also be added, and all the muscles inserted on the hyoid mechanically modify their tension state.

In cascade, the infrahyoids react by increasing their tension in an attempt to oppose elevation, but

being subdominant they are unable to restore the bone to a neutral position. Compensations are thus created and propagate to the connected regions through the shared muscular insertions.

### **3.1 Functional consequences of suprahyoid dominance**

When the hyoid muscles enter into excessive tension and subsequent shortening, the altered position of the hyoid bone produces functional modifications in swallowing, phonation, and respiration.

#### **Alterations of swallowing**

In physiological swallowing, the hyoid muscles work in synergy with the mandibular closing muscles.

Occlusal problems or cranio-cervical musculoskeletal imbalances may interfere with the proper balance between these two muscle groups, leading to atypical swallowing patterns.

#### **Alterations of phonation**

Variations in vocal frequency depend on the position of the larynx: for the production of high-pitched sounds, the larynx rises through the action of the suprahyoids; for low-pitched sounds, it descends through the action of the infrahyoids.

The hyoid bone, connected to the larynx through the thyrohyoid membrane and the thyrohyoid muscle, passively participates in these movements.

With the hyoid bone stably elevated because of suprahyoid dominance, the caudal excursion of the larynx is therefore limited.

The voice tends toward higher frequencies, not in volume but in timbre, with reduced modulation capacity, and the persistent excess muscular tension may lead to vocal fatigue.

#### **Alterations of respiratory mechanics**

During physiological inspiration, the hyoid bone should accompany diaphragmatic descent through the action of the infrahyoid muscles, then return to a neutral position during expiration. With the hyoid bone stably elevated because of suprahyoid dominance, the inspiratory caudal movement may be limited or absent.

The infrahyoids, already under tension in their attempt to oppose elevation, are unable to mobilize the bone effectively downward.

The bone remains fixed in an elevated position instead of following the respiratory rhythm, interfering with physiological respiratory mechanics.

#### **Alterations of cranio-cervical axes**

The tensions of the muscles connecting the hyoid bone to the cranium and scapula participate in maintaining cranio-cervical axes.

The altered position of the bone mechanically modifies the tensions of all the muscles in the region, contributing to changes in cranial position, alterations of cervical curves, and cranio-cervical tension asymmetries.

## **4. Clinical assessment**

Assessment of the hyoid bone provides information about the tension state of the system.

On direct palpation, the hyoid bone should theoretically lie midway between the inferior mandibular border and the thyroid prominence.

In clinical practice, it is often found elevated because of suprahyoid dominance; its distance from the inferior mandibular border is therefore assessed, together with its symmetry relative to the

midline.

During swallowing, its vertical and anterior excursion is observed, and during phonation, its positional changes with vocal frequency variation are assessed.

The elevated and anteriorly displaced hyoid represents the most frequent pattern and indicates excess tension in the suprahyoid muscles.

Through the muscular connections, anterior displacement of the hyoid bone also produces anterior traction on the middle cervical vertebrae, especially C3-C4, modifying physiological cervical lordosis.

This alteration of the cervical axis is associated with tensions in the mandibular region and cranial base, limited caudal excursion of the bone, a voice tending toward higher frequencies, and possible atypical swallowing.

Lateral deviation indicates asymmetry of tension on the two sides, generally due to unilateral traction of the omohyoid secondary to imbalances in the scapular region.

A real lowering of the hyoid bone is rarely observed, given the vector dominance of the suprahyoids.

## Conclusions

The hyoid bone, lacking articulations with other skeletal segments, represents a point of mechanical convergence of muscular forces arising from the cranium, mandible, sternum, and scapula.

Its position in space reflects the balance of these forces.

Vector analysis shows dominance of the suprahyoid muscles which, in the presence of tension alterations, produces a characteristic pattern: elevation and anterior displacement of the bone, with possible lateral deviations but without true lowering.

Alteration of hyoid bone position produces direct mechanical consequences: modification of cervical lordosis through anterior traction on the middle vertebrae, alterations in swallowing and phonation, and interference with respiratory mechanics.

Understanding the role of the hyoid bone as a point of mechanical redistribution of tensions makes it possible to interpret cranio-cervical symptoms that may derive from distant muscular tensions, propagated precisely through the anatomical connections converging on the bone.

## 5. Chapter summary

### **Bone without articulations**

The hyoid bone does not articulate with other skeletal segments. Its position is determined exclusively by the balance of muscular forces.

### **Point of mechanical convergence**

It represents the point where muscular forces from different regions converge. Positional variations are passive consequences of the balance of these forces.

### **Multiple muscular connections**

Muscles from the mandible, cranium, tongue, pharynx, larynx, sternum, and scapula insert onto the hyoid bone.

### **Mechanical redistribution of tensions**

Tension variations in one region modify the position of the bone, mechanically altering the balance of all the other inserted muscles.

### **Vector dominance of the suprahyoids**

The suprahyoids prevail over the infrahyoids because of number, strength, and a more favourable vector arrangement.

### **Characteristic positional pattern**

In the presence of tension alterations, the hyoid bone elevates and moves anteriorly. True lowering is not observed in clinical practice.

### **Action of the omohyoid**

The omohyoid may produce lateral deviations but does not effectively counter the upward traction of the suprahyoids.

### **Functional consequences of elevation**

A persistently elevated hyoid bone may produce alterations of cervical lordosis, atypical swallowing, a high-pitched voice with reduced modulation, and respiratory interference.

### **Propagation of remote tensions**

Cranio-cervical symptoms may derive from distant muscular tensions propagated through the converging connections on the hyoid bone.

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