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Baseline of upper teeth: (a) Control organ for spatial navigation? (b) Weak point for misaligned posture and pain?

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ABSTRACT

Our observations question both the current doctrine of spatial orientation as processed by vestibular, visual and proprioceptive impressions as well as the horizontal alignment of the eye axis. Indeed our observations suggest spatial orientation as a physically based, largely mechanically transmitted interaction between individual and environment. It is controlled by an interface defined by the baseline of upper teeth. It simultaneously constitutes both body and environment acting as an integral part of that environment. Consequently, the baseline of upper teeth is part of the aforementioned environment. Instead of the eye axis during spatial orientation it aligns the true horizontal absolutely. This was tested by fixing a cross to upper teeth. While walking, running and jumping it did not deviate by more than 2° from the external axis. Subsequently, we inclined the baseline of upper teeth by inserting an asymmetric wafer so that it angulated the eye axis. Immediately, head, visual and vestibular axes tilted unstably with misaligned body posture. Only the indicative cross remained stably aligned to the external axes. The person felt "upright", not noticing his posture had changed. He was then instructed to straighten his shoulders and trunk until his posture was objectively nearly upright again. The voluntary correction caused the indicative cross to tilt. The person felt uneven while being more upright. We concluded that the automatic posture works by "synchronizing" the baseline of upper teeth to the external axis and that the synchronized position is supported by the vestibular system.

Benefit of an interface is that the body's movements in the environment simultaneously happen within the baseline of upper teeth. Therein the vectors of the body and the environment are calculated to remain in balance. This model introduces the transmission of the vector information to postural muscles by the dura mater, controlled by tension between C0-C2. The information is skewed by bony dislocations between C0-C2 caused by an inclination of the interface. The resulting misalignments of posture are foreseeable and specifically correspond to the type of inclination. They occur in a broad section of the population. Diagnosed as muscular weakness, they may cause therapy resistant common diseases like back and joint pain after 5–10 years. Following our observations, the inclination of the baseline of upper teeth originates from inattentive changes in the length of upper teeth in dental treatment. Multiple treatments optimizing teeth length in long term patients improved the patients' situation.

Introduction

Our approach originates from an observation on a patient who was undergoing dental reconstruction. We prepared two temporary versions of an upper bridge with different teeth lengths in order to choose the better one. We observed a change in head posture by changing the bridges: Each of the provisional replacements resulted in distinct head posture. We excluded occlusion as causal because there was no tooth contact since the patient was edentulous with the lower jaw. Looking for a bodily reference which the change in posture might refer to, we did not find any because the whole body posture changed. We reproduced this phenomenon in various tests by inserting splints of 2–6 mm of thickness or replacing temporary bridges of the upper jaw with flatter or thicker ones. Changes in posture appeared regularly, specific to the thickness and the location of the inserted splints (see: Table 1). We assumed that the baseline of upper teeth referred to an extracorporeal parameter, such as the true horizontal. We proved this by fixing a cross to the upper teeth and noted it remained stationary while walking. If the baseline of upper teeth angulated to the eye axis, only the baseline of upper teeth was aligned to the true horizontal, whereas the eye and ear axes tilted unstably (see "Baseline of upper teeth consistent to the external environment. Trial"). Our idea was that this space may serve as a common denominator or an interface between the individual and his environment, creating an interaction. The baseline of upper teeth presents the position of the true horizontal and the gravitational direction. Thereby it acts as the external environment. This should help to deal with the rules of gravitation within the abstract, invisible and air-filled space (see: "Integral part of the environment within the head").

Our view extends the current view on posture, which is understood as being processed by vestibular, visual and proprioceptive impressions acting within the individual. In the current model, posture results from

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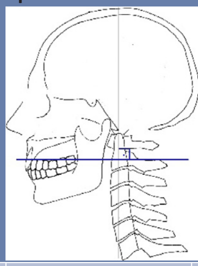
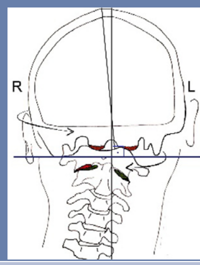
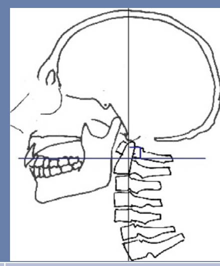
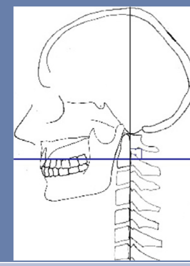
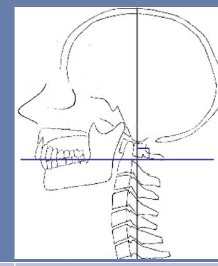
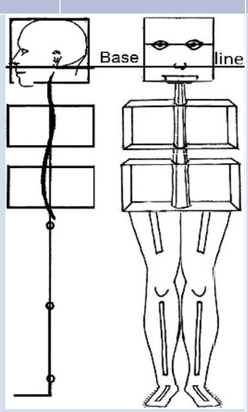
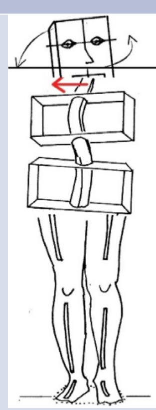
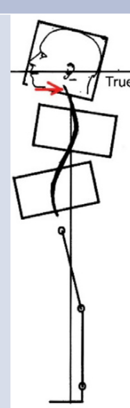
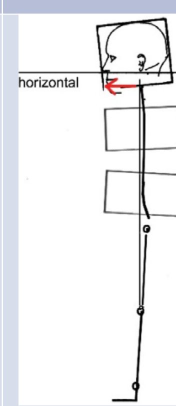
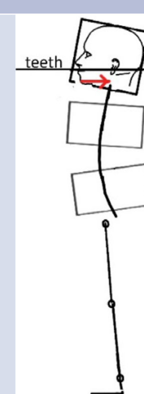
Table 1
Dependency of posture on the relative position of the baseline of upper teeth to the head.

	Normal (transverse) position	Ascending to the right	Ascending to the back of head	Descending to the back head	Descending to the front of head
Position of interface space to head (blue horizontal line)					
NHP	Head is upright	Head tilts to the right, rotates to the left	Head tilts backwards, thrusted forward	Head rises in the back	Front of head rises
Lower to upper jaw	centric	right (red arrow)	dorsal (red arrow)	ventral (red arrow)	dorsal (red arrow)
Dens axis to occipital condyles	Perpendicular below occipital condyles	Left from perpendicular	Dorsal from perpendicular	Ventral from perpendicular	Ventral from perpendicular
Position of joints C0-C2	Neutral position congruent and well-aligned, coping well with strain	Atlas tilts/rotates to the right, axis tilts and rotates opposingly, atlantoaxial joint incongruent and out of joint, strained. Longitudinal axis of C0-C2 angulates to the head	Atlas, axis shift ventral and tilt backwards, atlantoaxial joint compressed. Lordosis increases. Spinal processes approach (distance reduces dorsal)	Atlas shifts slightly dorsally to occipital condyles and steepens. Lordosis flattens	Atlas and axis shift ventral, tilt backward.
Dura in NHP between C0-C2	Straight, normal tension, motor action normal	Slackened in the right, motor action in the right segments reduced	Dorsally slackened, motor action in the dorsal segments reduced	Dorsally stretched, motor action in the dorsal segments increased	Ventrally stretched, motor action in the ventral segments increased
					
Shoulder girdle	Neutral	Lowered in the right, rotating dorsal in the right (tilt, shift to the right)	Dorsal, perpendicular behind pelvis. Kyphosis of thoracic spine increased	Ventral shift. kyphosis of thoracic spine reduced	Ventral from the body's axis
Pelvis	Neutral	In all the aspects opposing to shoulder girdle	In all sagittal parameters opposing to shoulder girdle, massive shearing forces on lumbar region	Steepened, pelvis "posterior"	Pelvis "anterior"
Trunk	Symmetric	Lumbar region twists twice a step, right side of trunk is shortened (concave, scoliotic)	Dorsal body wall shortens, hyperkyphosis combined with lumbar hyperlordosis	Dorsal trunk lengthens, Lordosis flattens	Trunk ventrally bowing, ventral trunk side lengthens
Legs	Legs move straight.	Swing leg moves in an arc (by rotation of lumbar spine), contacts laterally	Legs contact widely in front of the trunk.	Activity of hamstrings increased	Ventral leg activity increased

reflex bows, which are thought to align the eye and ear axes to the true horizontal [1]. Following our observations, eye and ear axis are inclined within 80% of the population, accompanied by misaligned posture and in addition to that by frequent back and other joint pain. Nonetheless, people only feel “upright” in their misaligned posture. Both aspects are largely therapy resistant in exercises and instructions. This is incomprehensible with the model of reflex bows. Finding the cause for misaligned postures should be of clinical importance. We propose the baseline of upper teeth as parameter that is superiorly aligned to the true horizontal. Eye and ear axis as well as the upright posture are subordinate to the baseline of upper teeth. The neurophysiological view on spatial orientation starts from impressions as well, creating a neuronal (virtual) image of the external environment within the head. Real motor action like turns of the head are indicated within this virtual image by head direction cells [2,3]. The other way round, the transmission from the neuronal image to motor action is not well understood. In particular, this refers to the anticipatory motor reactions to environmental obstacles/encounters. This is a weak point because navigation in daily life is based on the prospective control of obstacles. Anticipation requires the procession of time, which may only be experienced physically, e.g. by a moving body. The procession of time in the current model is “poorly understood” [4]. It should require a close connection between the physical and neuronal status.

Our model introduces the transmission from ideal spatial orientation to postural motor action (see: “Postural motor action and the modulation by the dura”). Spatial orientation in our model is an interactive automatic function to find food, to flee and to mate. It is problem-solving similar to cognition. Creatures anticipate the motor action to surmount an obstacle. They even anticipate pathways of others to swerve away from them or to contact them. This requires the procession of time and vectors. Sample: While crossing a road and approaching the curb, one's gait is reduced or increased automatically. This prevents us from tripping over the curb. Approaching a hollow, the prospective view mirrors/reflects which part of the foot is going to contact the supporting area and which muscles, joints, and bones are going to be strained, if the gait is not changed. If two cars of different speed approach each other at an angle, the observers are able to estimate place, force and angle of the encounter prospectively. Even the damage done to the occupants may be predicted. Even in tumbling on a slippery road, one's automatic reaction may save a pair of white trousers, a skirt, two bottles of wine or an injured ankle. This requires an understanding of the position and the tolerable strain of each limb, the changing position to the environment and a decision of preferences while falling. We sketch the automatic evaluation of vectors within a three-dimensional coordinate system with the baseline of upper teeth. It shows the spatial dimensions and the paths of others (see: “Coordinate system of three rectangular axes for vector calculation”).

Proprioception and the positioning between C0-C2 were found to influence posture and balance/dizziness [5–7]. This may refer to an absolute alignment of the baseline of upper teeth. A large number of proprioceptors and pathways run from C0-C2 to all regions of the brain performing spatial procession [8–10]. The dura mater in models of osteopathy is thought to modulate transmission to posture through tension [11].

Interventional studies of dentistry examinied the influence of occlusion on posture by inserting devices that were meant to change occlusion. The various studies used devices of different thickness. All in all, the results concerning occlusion were random. A closer look suggests that the results were proportionally influenced by the thickness of the devices, but not by the change in occlusion. Devices over 2 mm of thickness changed posture significantly [12–14] whereas devices below 2 mm of thickness only caused a slight change in posture [15,16]. This is supported by the dependency of head posture on craniofacial lengths [17,18].This suggests that the position of a specific craniofacial parameter, probably the baseline of upper teeth (see “Discussion”) may be the crucial point that influences posture.

Our initial observation suggested that the interface may be inclined relative to the head through length changes in upper teeth. This, however, happens frequently in dental treatment. It may be the cause of numerous disorders accompanied with misalignment and pain. Since most of the systems in the body are related to spatial orientation, the displacement of the baseline of upper teeth impairs multiple systems and may cause musculoskeletal and bowel pain, Temporomandibular disorders, exhaustion, depression and possibly fibromyalgia.

The present paper introduces transmission of the vectors by the dura mater in segments that correspond to the body cavity. This connection may be the missing puzzle piece in understanding back and joint pain accompanied by misaligned posture. It may be the key to the understanding, prevention and cure of frequently occurring disorders.

Hypothetically, synchronization to space by the baseline of upper teeth or corresponding mouthparts respectively is basic for orientation in space with creatures that move in space (e.g. insects or birds). On the contrary, the various kinds of equilibrium organs function relatively. With migrant birds, the vector-based framework in their beaks may constitute their enormous spatial orientation. No suggestion of a neurological or material sensor has ever been identified on their beaks [19]. The following text presents an overview addressing colleagues of all fields. Very specific details are excluded to enhance readability. A standardized investigation is still required since none of the authors are connected to an institute. Should you be interested in delving deeper into the subject matter, we would be pleased to be of assistance.

Integral external environment within the head

Our basic hypothesis is that the individual provides an interface within his head that simultaneously constitutes both body and environment. The interface is a small space defined by the baseline of upper teeth. It acts as an integral part of the environment presenting the true horizontal and the gravitational direction.(Fig. 1).

The baseline of upper teeth is a borderline without thickness, providing a spatial architecture: it is shaped like a horseshoe with upward curved ends and a cusped surface. It forms a rectangular framework of perpendicular axes. We observed the baseline align the true horizontal and the gravitational direction. Its sagittal axis represents the direction of the personal goal, i.e. the focal or movement direction during orientation in space. Remarkably, the sagittal axis represents an ideal personal vector (Figs. 2 and 3) that also appears with the subjective imagination of a three dimensional environment. By aligning the axes,

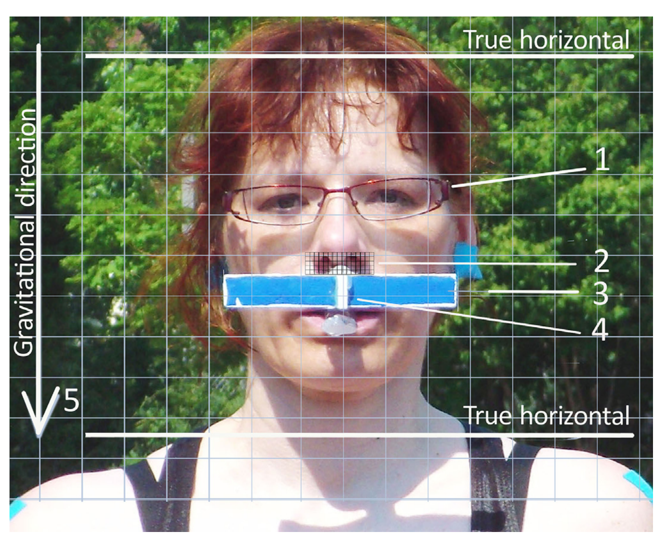


Fig. 1. (1) Eye and ear axes (inclined); (2) Grid (aligned), acting as integral external environment (3) Marking cross fixed to upper teeth (4), Personal focal direction; (5) Grid, external environment, alignment identic to (2)

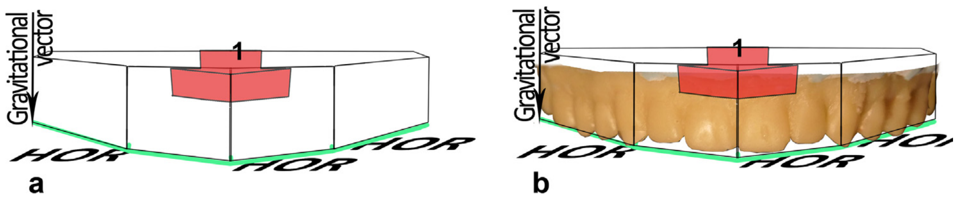


Fig. 2. Frontal view on framework (interface) of baseline of upper teeth (A) Schematic shape built up of gravitational vector, True horizontal plane (HOR) and (1) personal focal/ movement direction B) Anatomical baseline of upper teeth (green line) as basis of the framework. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

the individual will be "synchronized" to the external environment (Fig. 4). On the one hand the bodily structure of the baseline of upper teeth in its localization defined to the body, on the other hand to the external axes. This aspect has never been described before.

In our model, the external environment is perceived/ imagined as a three dimensional framework related to the baseline of upper teeth. Consequentially, the perception of space has got a physical base and does not originate from the visual perception. This is supported by the fact that even blind people experience this framework.

Synchronization by means of the interface makes it possible to control posture and movement and to remain in balance automatically. Our model describes spatial orientation, posture and navigation in space as a complex system that interacts with all other systems of the body. It plans and performs spatial navigation to find food, to flee and to mate. It processes time and vectors to control environmental encounters and obstacles, prospectively. It chooses the most appropriate path to the goal. In our model, this system shows the body's movements, the current and prospective the paths in the environment simultaneously within the baseline of upper teeth. This presentation is vector-based. It serves to calculate the body's position relative to the gravitational vector to remain in balance. The interface makes possible to calculate the interacting vectors of the body and the environment during motion. It additionally presents the path of others to control environmental contacts prospectively, which may be provoked or avoided.

The introduced model applies to orientation in space which in our view includes the automatic gait and the derived movements, but not to voluntary movements or sitting in an armchair.

Baseline of upper teeth consistent to the external environment. Trial

To prove the spatial consistence of the baseline of upper teeth, the reader is invited to reproduce the following trials, in which the position of the baseline of upper teeth is indicated by a cross. To evaluate the trials, the cross may be focused centrically by a normal video camera or to get a gold standard, by a 3D video recording with passive markers in the calibrated room.

First trial: A cross was fixed to the upper teeth of a person. The person was asked to stand in his or her "normal position" while focusing on the camera. NHP (normal head posture) and body posture were recorded (Fig. 5). The cross now has to be manually aligned to the true horizontal, pointing to the camera. The person was then asked to walk in a straight line towards the camera (the personal target). When evaluating the video recordings, the single frames show that the cross remains in the true horizontal and point to the camera by 2°, even in running and jumping (Fig. 6).

Second trial: The consistent alignment may be proven by inclining the baseline of upper teeth relative to the head so that it angulated the eye axis. This was done by replacing the current temporary bridge in the upper right jaw with one that was 3 mm flatter (The change in length may also be done by inserting a wafer of asymmetric thickness). The new situation was given 3 min of adaptation. In free standing, only the sagittal axis of the baseline of upper teeth pointed directly to the camera, whereas the pupils squinted. Then the cross was again aligned manually to the true horizontal and pointed towards the camera as before. Five minutes after the insertion of the wafer, the person was asked to approach the camera with the displaced baseline of upper teeth.

The cross was found to be as spatially consistent as before. The body posture and NHP appeared to be altered. The head tilted to the right and rotated to the left (Fig. 7), the right shoulder moved dorsally and lowered, indicating a rotation and a tilt of the shoulder girdle to the right. Additionally, the shoulder girdle shifted to the right. The pelvis behaved opposingly in all parameters, it rotated, tilted and shifted to the left. The spine in between was bent and twisted with the vertex/the centre of rotation located in the lumbar spine. The direction of twist alternated twice per step. Such is usually diagnosed as scoliosis, kyphosis or lordosis. In walking, the right leg was brought forward with an arc, the foot touched the lateral edge. Movement appeared cork-screw-like, similar to a sloping crank handle. The interpupillary line and vestibular axis were sloped, rotating around the true horizontal (Figs. 8 and 9).

The person was asked about his subjective impression of his posture (he had not been informed of having taken adverse posture), he told the researchers that he felt "upright". Only the cross was aligned to the true horizontal and pointed to the camera as a personal goal. Body posture was misaligned. Body sections tilted, rotated and shifted as described above. To examine the influence of voluntary control of posture, the person was instructed to level his shoulders and to straighten his trunk until his posture was objectively nearly upright again. This voluntary correction made the cross tilt. The person subjectively felt "uneven" while being more upright. Having resumed his cork-screw posture again, the cross was realigned, and he felt well aligned.

We concluded that the automatic posture works by "synchronizing" the baseline of upper teeth to the external axis. We concluded further that the vestibular system supports the synchronized position of the baseline of upper teeth irrespective of its position relative to the head. It does not primarily reproduce a horizontal alignment of the vestibular axes. The subjective feeling of an "upright" or "balanced" posture does not depend on the horizontal alignment of the vestibular axis, but on the synchronized alignment of the baseline of upper teeth. We concluded that the synchronization of the interface was superior to an upright posture and to the horizontal alignment of the IPL and

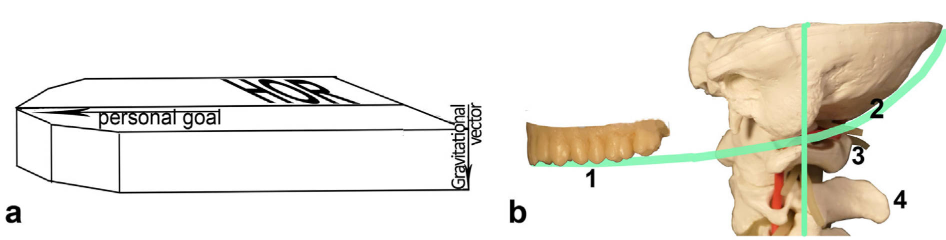


Fig. 3. Profile view on (A) Blank shape built up of gravitational vector, True horizontal plane (HOR) and personal goal (see Fig. 14); B) Anatomical view on (1) baseline of upper teeth (2) Occiput; (1) + (2): Common plane; (3) Atlas; (4) Axis.

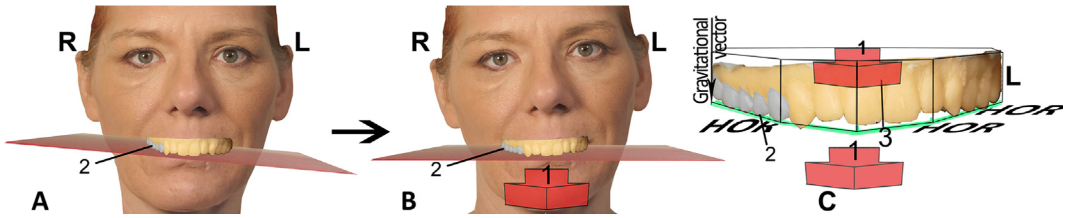


Fig. 4. Baseline of upper teeth ascending to the right side of the head due to a too short bridge in the right.. (A) non-synchronized; (B) Synchronized; C) Anatomic view (1) Personal focal direction (2) too flat bridge (3) Centre of teeth/ median of head, deviating from focal direction (1) .

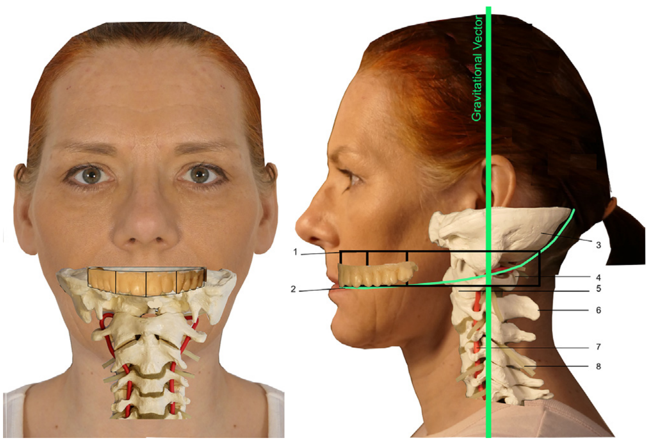


Fig. 5. NHP (normal head posture) with transverse (1) Baseline of upper teeth, in common plane with (3) occiput. Normal position of 4) Atlas; 5) Dens axis; 6) Spinous process of axis 7) Third vertebral body.

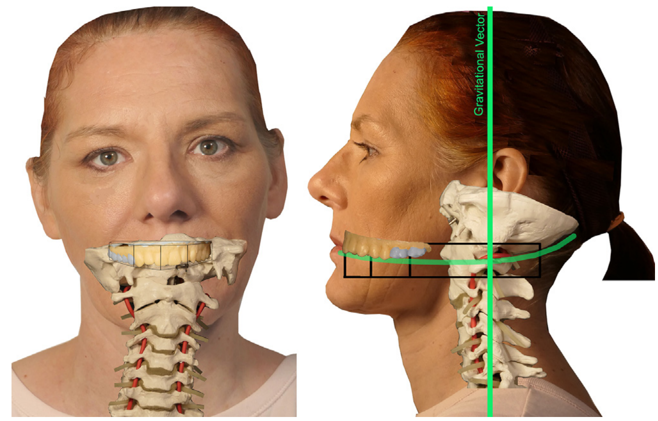


Fig. 7. Change of NHP through displacing the baseline of upper teeth relative to the head (too flat bridge). Head tilts to the right and dorsal to compensate the ascension of the baseline of upper teeth; atlas and axis are shifted forwards and tilted backwards.

vestibular axes as well. Inserting devices of 4 mm or more, we observed the marking cross deviate for fractions of a second from its axes. This was accompanied by a subjective loss of balance and objectively noted movements of the limbs as to restore balance, which continued until the cross was restored in the synchronized position again. We concluded that an inclined baseline of upper teeth is difficult to synchronise, because this requires a permanently changing adverse body posture. This aspect may be the connection between the aforementioned findings of neck posture (C0-C2) and dizziness/ poor balance, in patients with proper function of vestibular system (see “The jaws: Balance system of the vectors”).

However, this questions the current doctrine suggesting that IPL and the vestibular axis would be aligned horizontally. We deduced that the NHP (normal head posture) is dependent on the position of the interface relative to the head. The NHP (as well as body posture) will change immediately if the position of the baseline of upper teeth is changed and remains like that unless the position of the baseline of upper teeth **is** restored. This aspect may inspire the pending discussion on how to define the NHP [20].

We found foreseeable and specific misalignments of head and body posture caused by the displacement of the baseline of upper teeth (see Table 1). The movement appeared dysfunctional, inappropriate and “corkscrew-like”. This suggested a “misinterpretation” of vectors. This combination of an inclined baseline of upper teeth and impaired

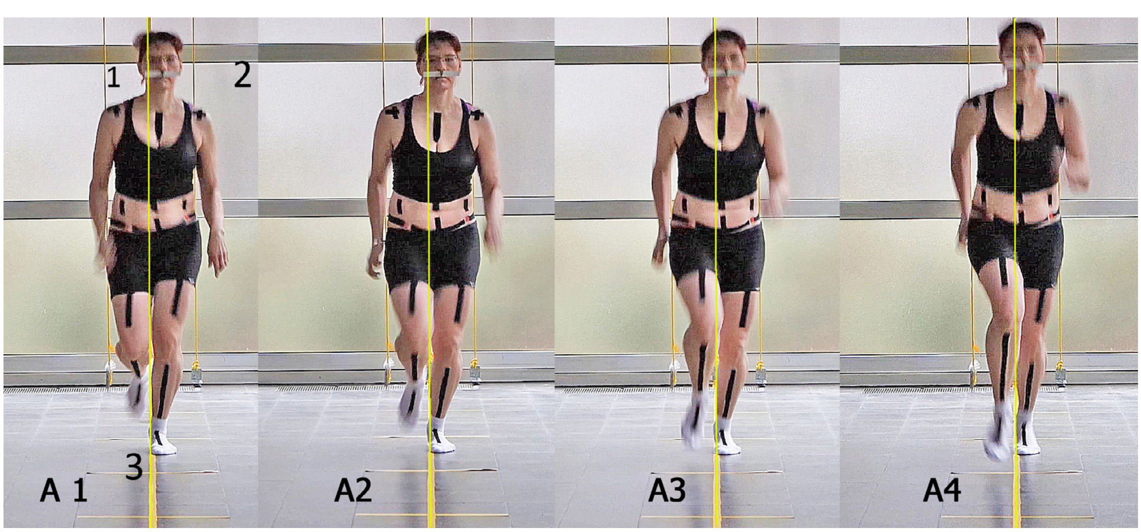


Fig. 6. Running with (1) indicative marking cross in front of the mouth, indicating the position of the baseline of upper teeth. (2) Perpendiculars and horizontal window frame (3) personal movement direction.

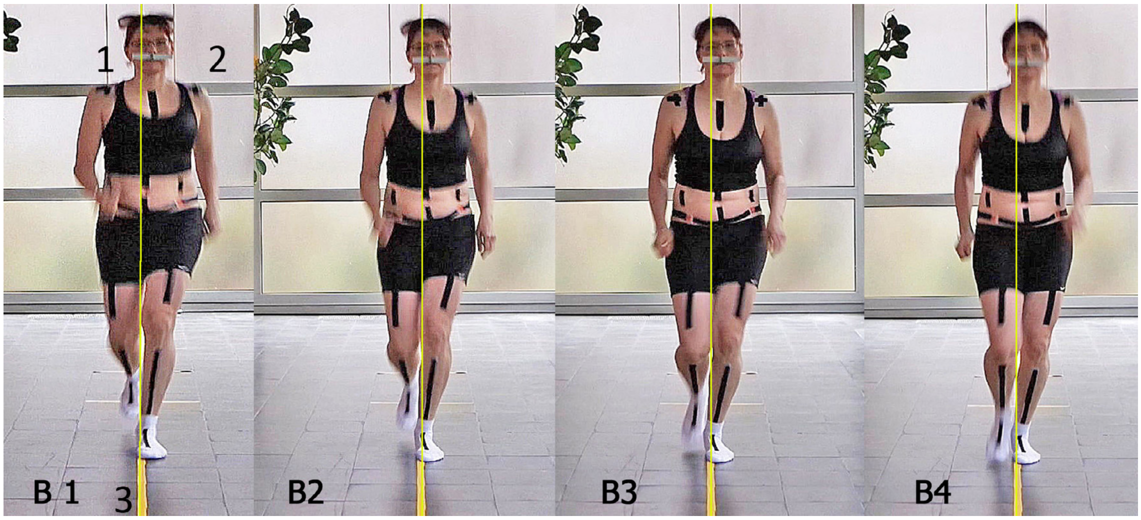


Fig. 8. Running with marking cross after iniclining the baseline of upper teeth. The head is tilted; pelvis and shoulder girdle rotate opposingly. The cross remains spatially consistent.

posture appears throughout the population (Fig. 10). The data of previous studies report similar changes in posture after the insertion of devices, which were meant to change occlusion. In our view, their interpretation of "descending chains", a change in posture resulting from a change in occlusion [12,14–16,21,22] is incorrect and misleading.

Coordinate system of three rectangular axes for vector calculation

Neurophysiological studies have found that visual perception interacts with the grid cells, but does not create the spatial model [23]. Visual impressions of environmental objects hypothetically become localizable by the insertion into this framework. Hypothetically, through the exact and itemized localization within the spatial framework, a two dimensional visual impression is transferred into a three dimensional one again.

The interface of the baseline of upper teeth may be understood as a three dimensional coordinate system. This aspect reminds one of grid cells. A personal goal is focussed on by aligning the sagittal axis of the baseline of upper teeth. This hypothetically corresponds to the function of HD cells that probably refer to this axis. Aligning the sagittal axis directly to this goal automatically determines the position of the two resting axes of the framework. This arrangement only works during automatic orientation in space and is interrupted by voluntary head movements. Navigating through the environment, the inner space of the baseline of upper teeth expands from the head into its outside environment, both fusing to one common space. While moving through the environment, the individual consequently moves in the expanded space of his own baseline of upper teeth. In order to remain in balance and to control encounters or obstacles, it is required to evaluate the own and environmental vectors in a fraction of a second. The interface shows all the current vectors: those of the movement of the body, those of the environment and the environmental objects.The sum of the vectors must be zero. The position of the body sections relative to the framework must be known. This may be the base to transfer the ideal vectors to motor action. The time of this procession is ultrashort corresponding to the time of latency of balance reactions. The prospective planning of paths and the control of obstacles requires anticipation and the procession of time. Hypothetically, without synchronization to the external environment, an individual should neither be able to relate himself to his environment, nor to remain in balance or to move purposefully. He should not be autonomous.

In the following, the term "position of the body in the external

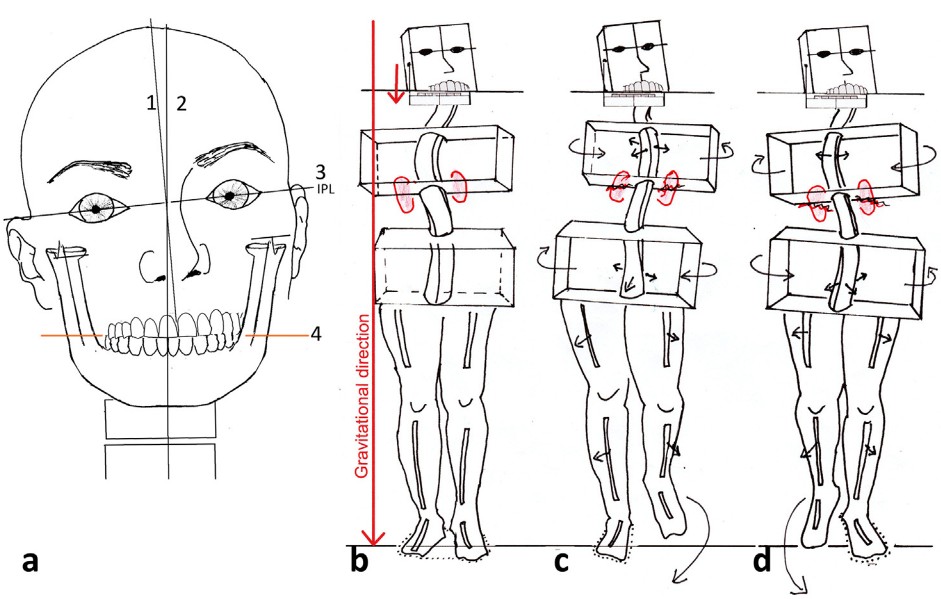


Fig. 9. A) Change of NHP. with baseline of upper teeth ascending to the right (4). (1) Median, (2) Gravitational. direction, (3) IPL (interpupillary line/ eye axis), B) Subjectiive upright body posture: Standing C) walking, supporting phase right C) walking, supporting phase left. Arrows indicate opposing rotations causing twists in lumbar spine and shearing of organs (kidney).

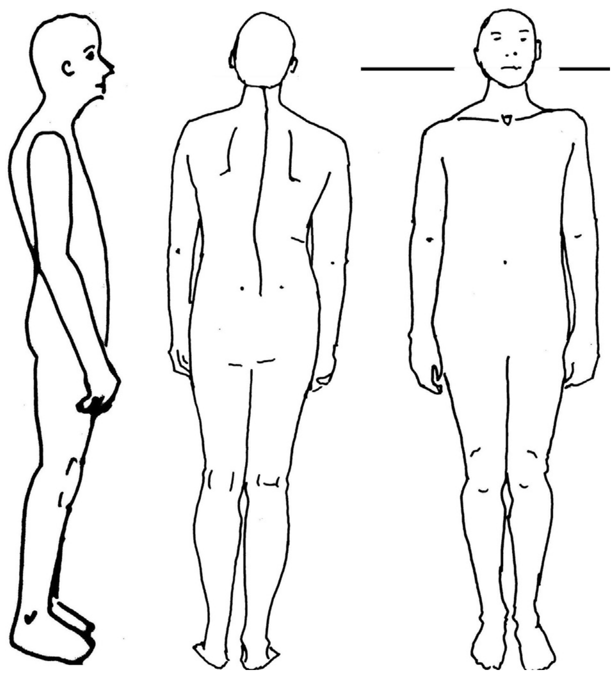


Fig. 10. Posture with baseline of upper teeth ascending to the right and dorsal. To synchronize, the head is thrusted forwards, tilts to the right; shouldergirdle rotates and tilts. Right side of body is shortened.

environment" is used. In contrast to "posture" it only describes the automatically controlled arrangement of the body sections with regard to the gravitational vector and the personal target. "Posture" additionally includes the voluntary modifications of its own appearance as well as aspects of mood, gender, force or lesions.

Common plane with the cranial base

To transmit the vector information from the ideal procession (interface) to the body (motor action), the relative positions of the body sections, limbs and muscles to the interface must be known in each phase of motion. Since the baseline of upper teeth is not fixed rigidly to the body, this hypothetically needs an additional dynamic coding. Looking for regularity in medical imaging of the head and neck, we observed that the occiput and the baseline of upper teeth are always on one surface with each other. The two planes merge into each other and build up one common, synchronized plane. This was seen in the profile and the frontal view. Originating from the upper front teeth, the line attaches the lower edge of upper teeth to the first molar and then continues running 2 mm below the molars to merge into the occiput. The common plane equates the foramen magnum with the passing dura mater to the baseline of upper teeth. Hypothetically, the (cross-sectional) circle of the dura mater becomes synchronized to the baseline of upper teeth (see "Postural motor action and the Modulation by the dura"). We assumed that this is the presupposition for the transmission of the calculated vectors to the body. We hypothesized the dura mater as the dynamic key.

Substantiating our observation of a common plane was that the common plane occurred even with inclined (ascending (Fig. 11) or descending (Fig. 12)) baselines of upper teeth relative to the skull – this was shown in the largest part of the images.

Despite the inclination of the baseline of upper teeth, we observed the occiput consistently in one line to it. Estimated 85% of the adult images showed an inclination of the baseline of upper teeth, mostly due to prosthetic length changes, the images of younger people due to orthodontic treatment. The alignment of occiput to the baseline of upper teeth in these cases was firstly produced through the remodeling of the occiput, a positional change relative to the resting skull; the head's shape thereby becomes asymmetric. Anatomically, the remodeling is not farfetched and understandable by a chain of perforations (passages of vessels and nerves) girdling the central (mobile) part of the occiput. From inside the skull, the central part of the occiput appears like a loose inlay in the skull (Fig. 13).

The second mechanism is performed by dislocations of occiput, atlas and axis (C0-C2) that dislocate correspondingly to the displacement of the baseline of upper teeth: An ascension to a certain side of the head (ventral, ventrolateral lateral, dorsolateral and dorsal) makes the head tilt to this side and rotate contralateral. Atlas and axis swerve and rotate opposing to the occiput (see Table 1). These efforts substantiate the hypothesis of a common plane, suggesting that the synchronization of baseline of upper teeth and the Foramen magnum is a superior requirement.

Postural motor action and the modulation by the dura

Postural motor action of the trunk is guided by the extrapyramidal (rubrospinal, reticulospinal, vestibulospinal, olivospinal) tracts. These pathways are located in the Fissura mediana, presumably an inflexible region, directly attaching the dura. In our model, the motor pathways guide the "pure" vector information. It may be assumed that this location protects itself from influences of the moving spine. Ascending proprioceptive information is guided by tractus spinocerebellaris anterior and posterior to the cerebellum to be compared with the descending motor signal. The ascending pathways also attach the dura, in contrast to the descending pathways they cover a large part of the lateral circumference, so presumably they are largely influenced by positional changes of the spine.

Postural motor action controlled through dural tension

We introduce a second mechanism that modulates the pure vector information of the motor pathways. This runs physically, basing on the common plane, which makes the cross-sectional circle of the dura equal to the circle of the baseline of upper teeth. The latter contains 16 teeth, corresponding to 16 segments. They correspond to 16 longitudinal segments of the dural tube. From the dural tube, the segments spread out radially (cake-sliced) to the body cavity, each of them covering 22.5° and involving all kinds of structures (Fig. 14). Seen from the side, the longitudinal segments run parallel from head to toe (Fig. 15). The dural tube thereby corresponds to the body cavitiy. In this model, the vectors are guided physically by the longitudinal segments. Hypothetically, motor response during normal balance reactions is precisely supported by a differentiated tension of the single segments of the dura. This may support the lengthening of the supported side. We hypothesize the dura as dynamic key for automatic motor action.

Inclined baseline of upper teeth: adverse influence on dura and posture

This physical aspect of guidance of vectors is a weak point in this system, since the dural tone may also be influenced by dislocations of occiput, atlas and axis. Since the dura is attached to the bones with C0-C2, an increase of their distance will stretch it, an appproach will slacken it. Hypothetically, stretch increases, an approach reduces the postural motor action in the very longitudinal segment. Corresponding motor endpoints were observed (see Table 1: "Dependency of posture on the relative position of the baseline of upper teeth to the head"). Sample: A baseline of upper teeth ascending to one (sample: the dorsal) head side will cause this head side to lower by an automatic tilt. C0-C2 will approach, the attached dura will slacken immediately. (Fig. 16). A combined tilt in two levels (e.g. lateral and dorsal) will produce a twist, probably the most harmful influence. Hypothetically, the physical guidance of vectors may be falsified through positional changes

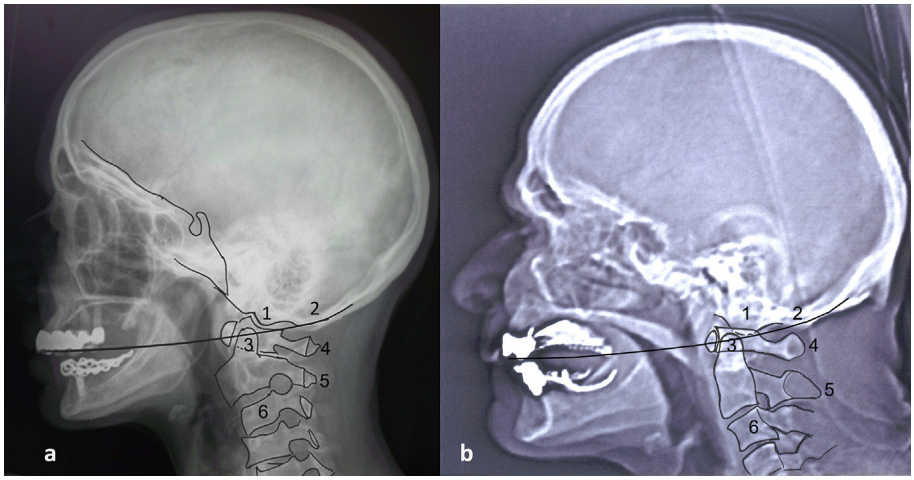


Fig. 11. Common plane of baseline of upper teeth and occiput with prosthetically caused ascension of baseline of upper teeth to the back of the head. (1) Occipital condyles, (2) Occiput (3) Dens axis (4) Atlas. X-rays taken in natural posture (NHP).

(Fig. 17). Postural motor action will be skewed, trunk and limbs twisted (Fig. 18). Correspondingly, we observed angulations and twists of structures of the CNS like myelon, dura, vessels, further muscles and ligaments. This may impair the structures (Fig. 19).

Summarizing, body posture and NHP may not only be a wise (calculated) response on environmental vectors (which is physiological) but may be adverse and falsisfied by angulation or twist of the transmitting dura (which is adverse) (see: "The jaws: Balance system of vectors"). Synchronizing a displaced baseline of upper teeth/ interface space will cause an adverse change of body posture and NHP, remaining as long as the dental displacement persists.

The idea of a physical influence of the dura on posture and movement is supported by the qualities of the dural sheet and the connections to regions of spatial procession. In the region C0-C2, the dura provides some extraordinary features supporting a role in the transmission of the neurophysiological procession of spatial orientation and posture. The perception of positioning in the region C0-C3 was found with local dural fibres spreading into the deep layers of the temporal and upper neck muscles and the ligamentum nuchae [24–28]. The dura originates from in and outside the skull and passes the foramen magnum. Only in the region C0-C2, dural nerve fibres pervade the skull through emissary canals and fissures connecting muscles to the inside dura. Fixed to suboccitical muscles as well as the bones (occiput, atlas and axis), the fibres build up various interlaced layers [29]. In contrast to the resting spine, the structures between C0-C2 are not attached to ligaments, but only to the dura [26]. The dura supports a huge amount of receptors and fast and ultrafast pathways [28–30]. Evaluating all data, superior control loops were found concerning the spatial position of the body [24–28]. They are located not only in the dura, but also in the neighbouring structures. They connect the C0-C3 region with all areas of the CNS that perform spatial orientation [10,31]. Particularly, the frontal association area (tertiary association field, combs) processes information of the C0-C3 region [32,33]. Furthermore, pathways involving the C0-C3 region run to the nucleus cuneatus, to the retrosplenial and the entorhinal cortex. This supports the hypothesis of the role of dislocations in the C0-C2 region by linkings the mechanical structures to the spatial processing areas of the brain.

The jaws: balance system of the vectors

In our model, the cranial base, the jaws and C0-C2 are a vector-processing balance system [34]. The state of balance is represented by the relative position of the jaws. In symmetric balanced standing, upper and lower jaw are congruent. In a one-leg-stand, during the supporting phase of walking or wearing a unilateral heel lift, the jaws shift (Fig. 20) passively and horizontally (as observed in [35–40]). The upper jaw

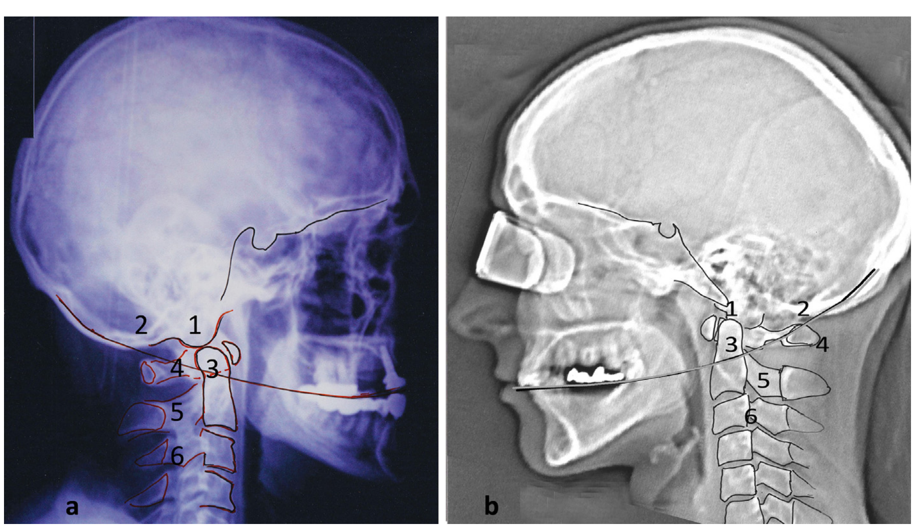


Fig. 12. Common plane of baseline of upper teeth and occiput with prosthetically caused descension of the baseline of upper teeth dorsally. 1) Occipital condyles, (2) Occiput (3) Dens axis (4) Atlas. X-rays taken in NHP.

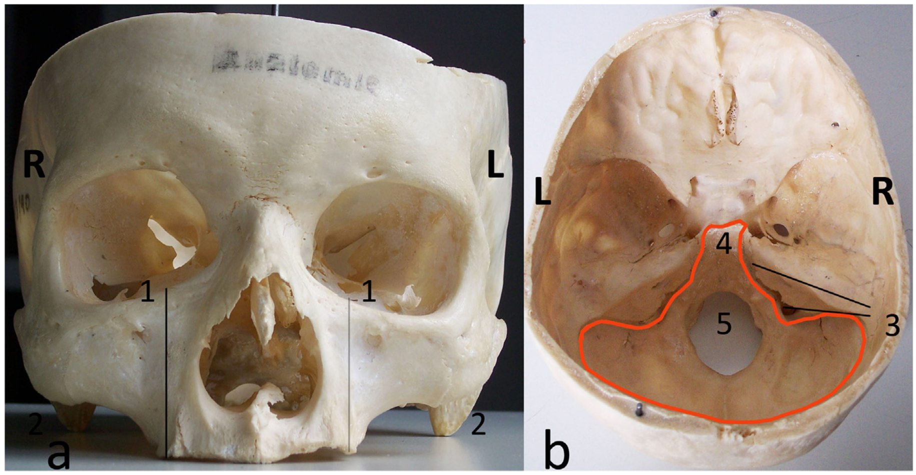


Fig. 13. Contorted skull consistent with longterm denture too thick in the left side (L). (1) Distance orbita- maxilla reduced by compression in the left (L); (2) Mastoid process, (3) Mobile part of occiput (marked) (5) Foramen magnum.

represents the vectors of the moving body. The lower jaw as a hanging bow represents the gravitational vector. It is inert and follows the head in a delayed mode. If the body and head change direction or speed, it will follow delayed, so the upper teeth will shift above the lower teeth. The interplay of shifting jaws changes tooth contacts. Horizontal shifts have got nothing to do with the chewing activity but are part reactions with respect to balance. Hypothetically, only the upper teeth perceive the acting vectors by compression and shearing forces acting on the baseline of upper teeth. Hypothetically, this is sensorial information of vectors, highly precise through the various locations of 16 upper teeth-receptors in the dental arc. To fulfill this task, the baseline of upper teeth/interface space must not deviate from its synchronized axes by more than 2°, otherwise the vectors acting on them will be interpreted inapplicably. This may happen if the baseline of upper teeth is extremely inclined. For this it is difficult to synchronize; huge deviations from the normal are not stably synchronized. Following our observations, this may cause dizziness in patients. Vectors are calculated with the interface space. The synopsis gives precise information about the vectors acting on the body, additionally differentiated through the cusped surfaces. Hypothetically, the mandible is a corrective of the upper teeth by restricting the deviation from the synchronized position by tooth contacts. Hypothetically, this tooth contact triggers a posture correction. In our model, the mandible is the true representative of the gravitational vector/ true horizontal. Its position to the gravitational vector is calculated in every kind of movement. Like an anchor it indicates the position to the true horizontal even beyond its range of motion of the temporomandibular joints. Hypothetically, in this case, the additional positional information is given in high resolution by various joint tissues. With a displaced reference space, the joint position is permanently asymmetric (Fig. 9a). The relative shift of the mandible with balance reactions is marked with red arrows (Fig. 20).

Dealing with the gravitational vector is the primary task while navigating through space. Thereto, the body's centre of gravity is automatically positioned perpendicularly above the supporting base. Standing symmetrically on two legs, the supporting base is as large as the area below and between the feet. In a one-leg-stand or while walking, the supporting base is as small as the area contacted by the supporting foot. The supported body side bends and lengthens convex from head to toe above the supporting foot [41]. Lengthening is the most important principle of balance reactions. The pelvis and shoulder girdle shift above the supporting area to serve as counterweights for the balancing leg. The head side bends and raises, too. This makes the baseline of upper teeth rise in the supporting side. It shifts relatively to the lower teeth. The bending/curving of the body may appear with all sides of the body cavity (dorsal, dorsolateral lateral, ventrolateral and ventral): Standing on tiptoes, the ventral segments of the body lengthen and bow ventrally, standing on heels, the dorsal segments lengthen and bow dorsally and standing on one leg, this side lengthens (Fig. 21). Note: It should be useful to recognize balance reactions. Putting a heel lift under one foot triggers a balance reaction including a shift of jaws.

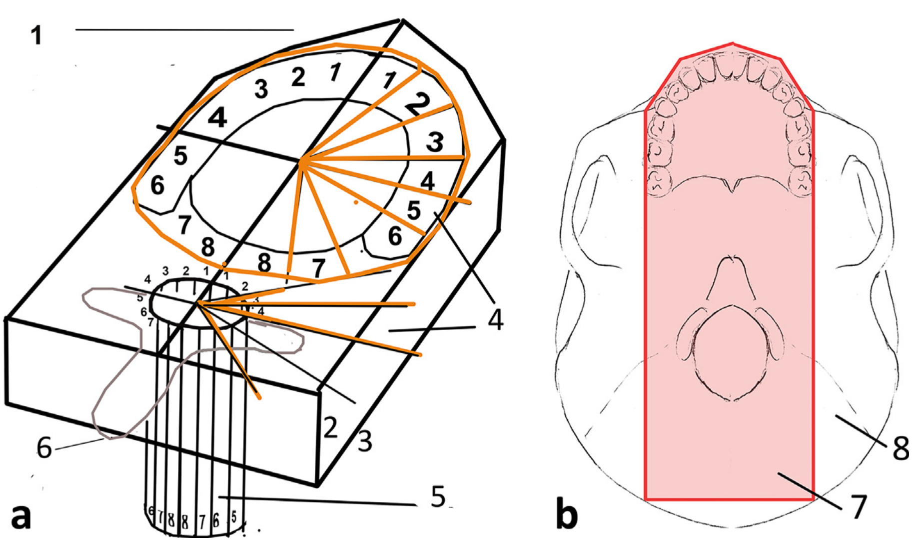


Fig. 14. Spatial framework of baseline of upper teeth A) schematic shape (see Fig. 3), B) Skull from below with integrated framework (1) Apex = Focal direction, (2) Vertical = Gravitational direction, (3) Base = True horizontal plane, (4) Baseline of upper teeth segmented with 16 teeth; corresponding with dura, (5) Dural tube (6) Vertebral body, spinous process.

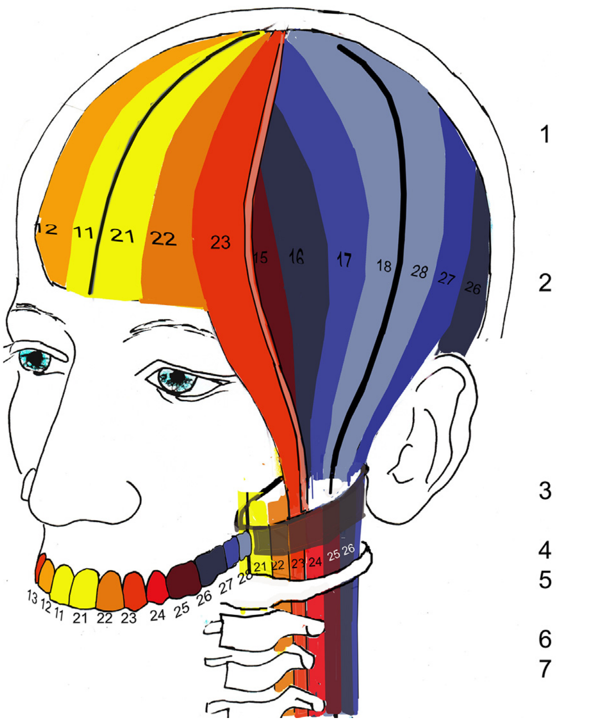


Fig. 15. (1) Skull, partly interior view, (2) Longitudinal segments of the Dura mater, numbered and coloured corresponding to the related upper teeth, (3) Foramen magnum, (4) Upper teeth, numbered, (5) Atlas, (6) Axis, (7) 3rd Vertebral body .

In numerous studies the shift of jaws was misinterpreted as "ascending chains", a "change in occlusion" resulting from "a change in posture" [36,40,42].

Seen from a different point of view, balance is the equivalent of all vectors A large part of them may be balanced mutually. Gravitation, however, has to be opposed by motor action. Hypothetically this is done through lengthening the spine, namely by muscles within the longitudinal segments. Hypothetically, these are the muscles of the deep layers in the spine, the transversospinal system, running in an A-shape and called Mm. multifidii and Mm. rotatores. Hypothetically, they lengthen the spine rather than performing a rotation: they pull the spinous process of the upper vertebral body to the transverse process of

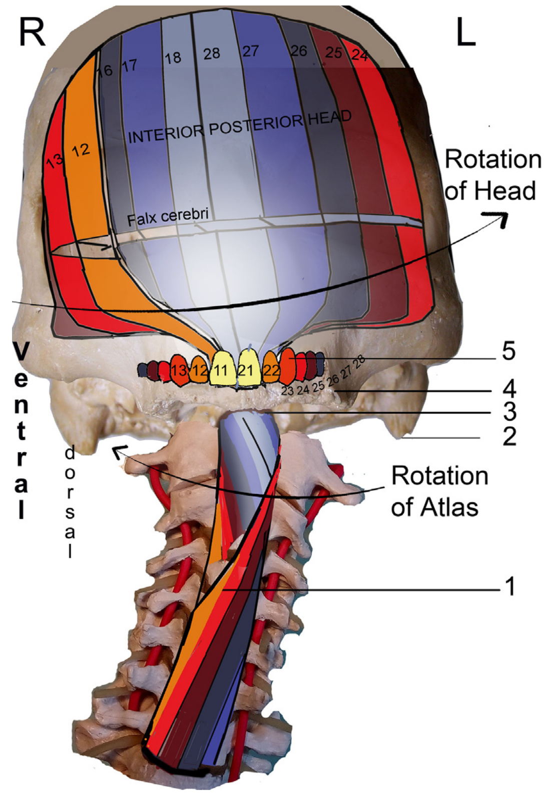


Fig. 17. (1) Longitudinal segments of dura, coloured and numbered corresponding to the related upper teeth, angulated and twisted due to a head tilt to the right and dorsal; (2) Mastoid process (3) Foramen magn. (4) Occiput, remodeled and angulated within the skull (5) upper teeth, numbered, with baseline of upper teeth ascending to the right and dorsal.

the lower one. This makes the upper vertebral body tilt to the opposite side, so that the intervertebral space increases ipsilateral. The ipsilateral side is the supported one. Additionally, the upper vertebral body slides along the vectors of the interface into the movement direction and above the supporting side.This effect is due to the long length of the spinous process(Fig. 22). The lengthening concerns the longitudinal segment running from head to toe. During motion, lengthening of the segments runs alternatingly.

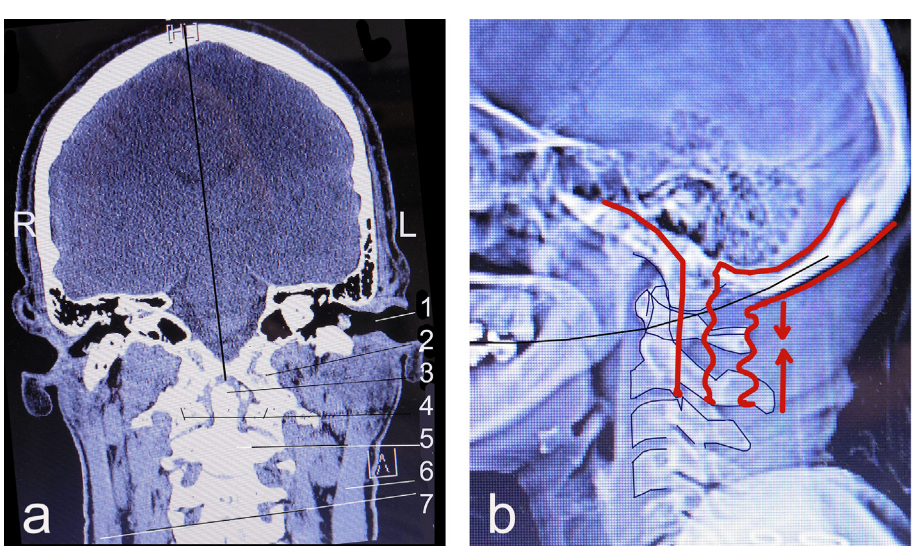


Fig. 16. Slackening of dura through approach of C0-C2 by head tilt A) to the right, B) dorsal. A) (1) Positional changes of Occ. condyles, (2) Atlantoaxial joint, (3) Dens axis, canted, (4) atlas, (5) Axis, (6) 3rd Vertebral. body (7) Sternocleidomastoid muscle. Patient with displacement of baseline of upper teeth.

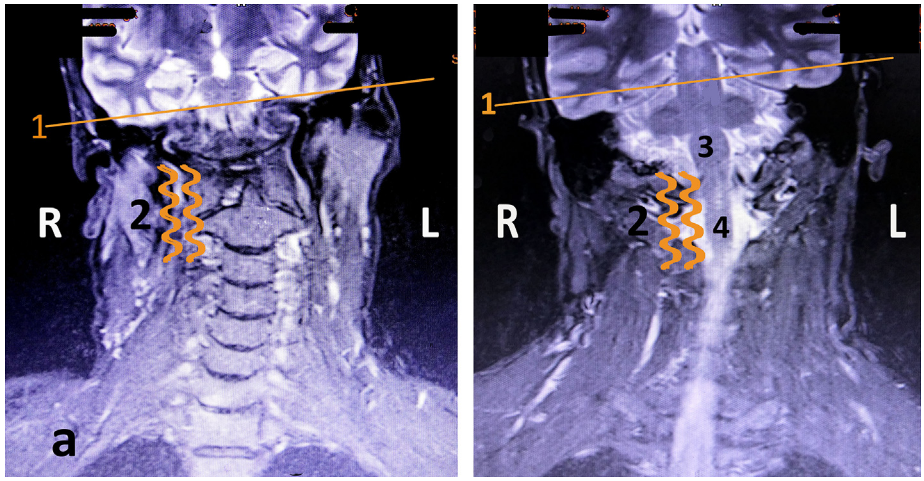


Fig. 18. (1) Vestibular axis, sloping (2) Dura mater showing slackening/twist/ angulation of the dura between displaced region C0-C2, (3) Pons, (4) myelon. Patient with displacement of baseline of upper teeth.

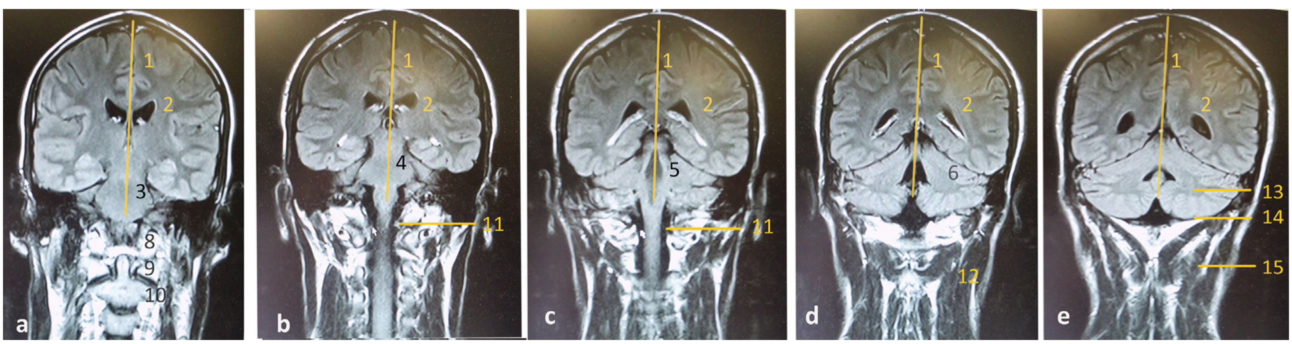


Fig. 19. Angulation, twist and shift of neuronal/vascular structures of the CNS. (1) Median (2) Cortex (4) Pons, (6) Cerebellum, shifted/ twisted, (8) Foramen magn. (11) Dura/ myelon angulated and twisted (12) Sternocl. muscle, (14) base of occiput. Patient with displacement of baseline of upper teeth.

Discussion

An influence on posture by the dental situation (and the "key" region C0-C2 as well) has been assumed forever. Correspondingly, connection between "the teeth and posture" has been researched for the last 30 years in numerous studies. The connection between the teeth and posture; however, was only focussed from the point of view of chewing parameters like occlusion. Interventional investigations looking for the connection between occlusion and posture changed occlusion by inserting devices. Only half of the investigations observed

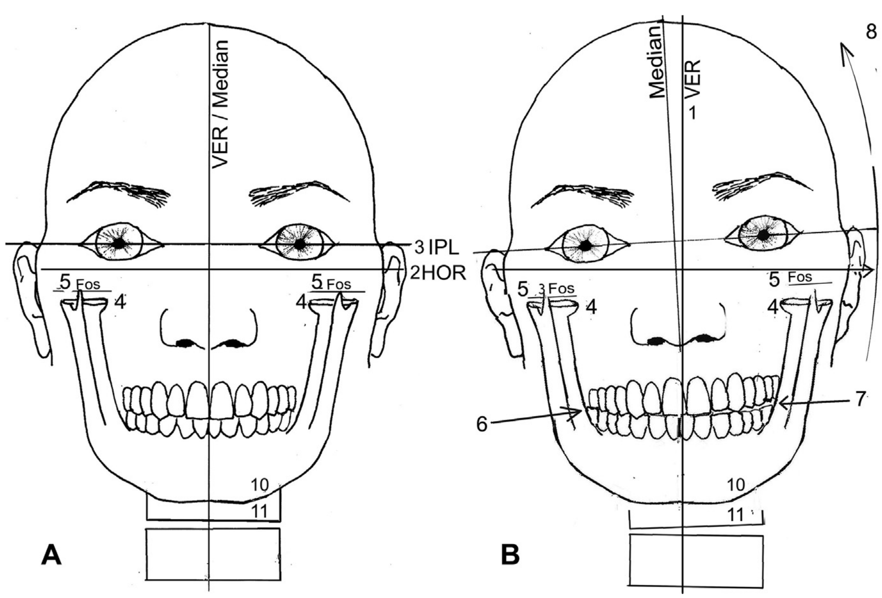


Fig. 20. Balance reaction with head and jaws. A) Upright tanding on two feet: jaws congruent, B) standing/walking on the left leg: left head side raises and shifts (7,8) (3) IPL, (4) Mandibular condyles (5) Fossa of temporomandibular joint, 6) Tooth contact, (7) gap.

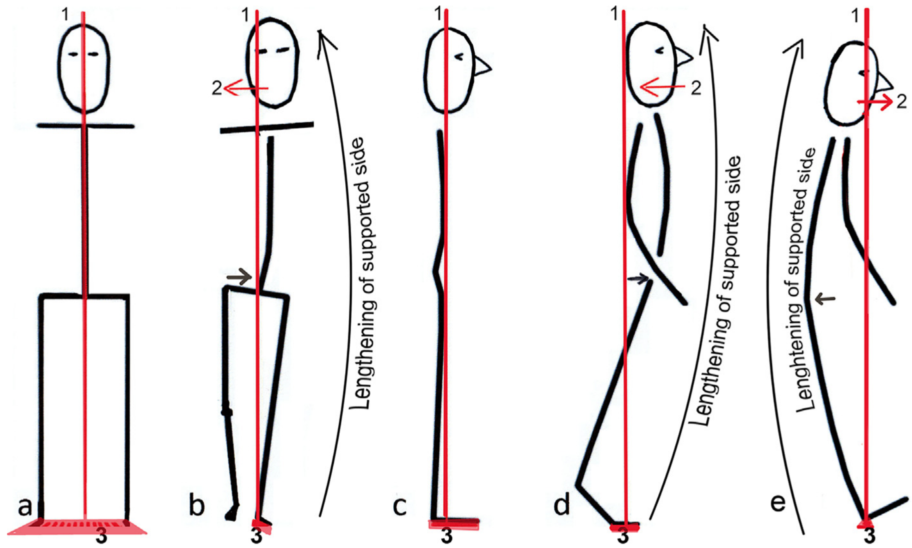


Fig. 21. Balance reactions: principle of lengthening in the supported body side (B-E; lengthening marked) to shift body sections above the supporting base. A) Standing on two legs without bending.

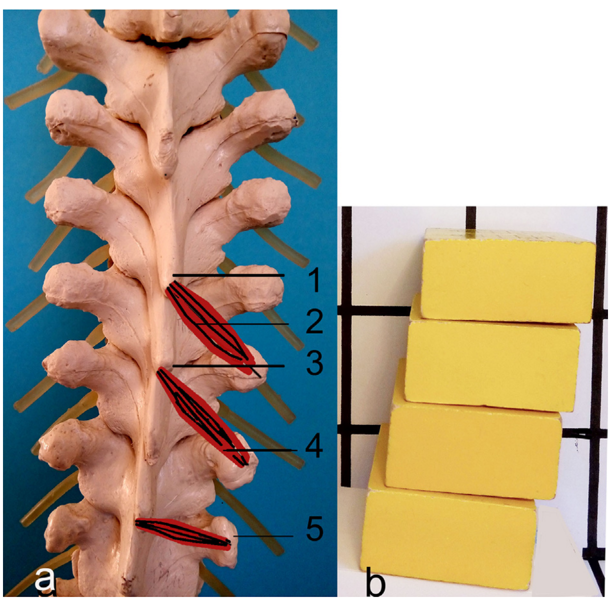


Fig. 22. Automatic lengthening of supporting side through Mm. rotatores (2, Mm. multifidii (4).The ipsilateral side lengthens by pulling the upper spinous process (1;3) to lower transverse process (4;5), B) Schematic, showing opposing tilt of vertebral body and slide into movement direction and towards supported side.

a change in posture. Evaluating all of them, only the studies using devices of more than 2 mm of thickness reported a significant change in posture [12,22,43–45]. The kind of changes in posture corresponded to our observations. It was probably caused by the thickness of the devices rather than by the change in occlusion. Studies using devices with less than 2 mm of thickness or devices that were inserted to the lower jaw did not report a significant change in posture [15,16]. This is supported by results of non-interventional studies and meta-analyses that also did not observe correspondences between the occlusion and posture [46,47]. A dependence of head posture on teeth length and craniofacial distances has been found various times [18,48,49]. Although the results in toto did not speak for an influence of occlusion on posture, it is well-known that occlusion was attributed to influence posture and became the focused parameter in dentistry. . A complex doctrine was established claiming that the chewing system was connected to the posture or to the musculoskeletal system [50]. This influenced the guidelines of dental treatment and temporomandibular disorders as well. It may be a fatal mistake with serious consequences for the population because creating occlusion in a dental treatment was largely done at the cost of the length of the teeth. The developing adverse changes in posture or the origin of Temporomandibular disorders were never traced back to a dental length change.

Previous studies claimed that a “change in posture” would change occlusion (“ascending chains”). The “change in posture” was done by applying a unilateral heel lift or further changes of the supporting base [35–37,40]. Following our observations, this triggers a balance reaction including a shift of jaws. In the quoted studies, the shift of jaws was not noticed as part of a balance reaction and therefore misinterpreted as a “change in occlusion”. To date, the shift of jaws has never been brought into relation with the gravitational force but only with muscular activity. A postural role of the baseline of upper teeth has not been considered to date.

The present paper points out that the researched connection to posture may be the teeth, but not part of the chewing system. In the view of the present paper the searched parameter is the position of the baseline of upper teeth relative to the head - a superior parameter of spatial orientation and the postural system.

Possible consequences

This approach combines interdisciplinary features to lighten the bodily aspect of orientation in space and involves additional aspects than previous approaches. The introduced aspects may be the missing puzzle piece to understanding misalignment and strain. It offers a causal relationship to prevent and cure disorders resulting from a displacement of the baseline of upper teeth. Following our observations, this happens inattentively in dental treatment. An awareness of this issue may reduce the incidence. This seems relevant since these disorders have an estimated prevalence of 80% in people over 30 years old. Performance of athletes is concerned, too. Following the view of the authors, even Temporomandibular disorder (TMD) originate from a change in the length of upper teeth. The multiple symptoms and the systemic appearance of TMD is understandable because this manipulation concerns the superior parameter of the most important system. This system maintains comprehensive interrelationships and is involved in the largest part of functions in the organism, which consequently, get concerned with the impairment. This may be the reason for the broad variety of symptoms appearing with TMD. The noxe producing pain after years in our view is shearing forces. Acting permanently on the body, they damage its structures progressively within several years. Back pain, dizziness, depression, bowel and joint pain as well as loin pain hematuria syndrome may result from a displacement of the baseline of upper teeth.

Based on our experience, the frequently occurring adverse posture with pain is improvable by restoring the baseline of upper teeth. This should be also relevant with athletes to improve an ergonomic function and prevent pain and injury. Treatments have shown that this even applies to long term and elder patients. Preventively, it should reduce the incidence of dependent disorders. Should you be interested in delving deeper into the subject matter, we would be pleased to be of assistance.

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