

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/368874102>

Orientation control system (engl)

Presentation · February 2023

DOI: 10.13140/RG.2.2.10834.63687

CITATIONS

0

READS

235

2 authors:



Ruth Nebel

16 PUBLICATIONS 11 CITATIONS

SEE PROFILE



Anne Kapp

independent

3 PUBLICATIONS 2 CITATIONS

SEE PROFILE

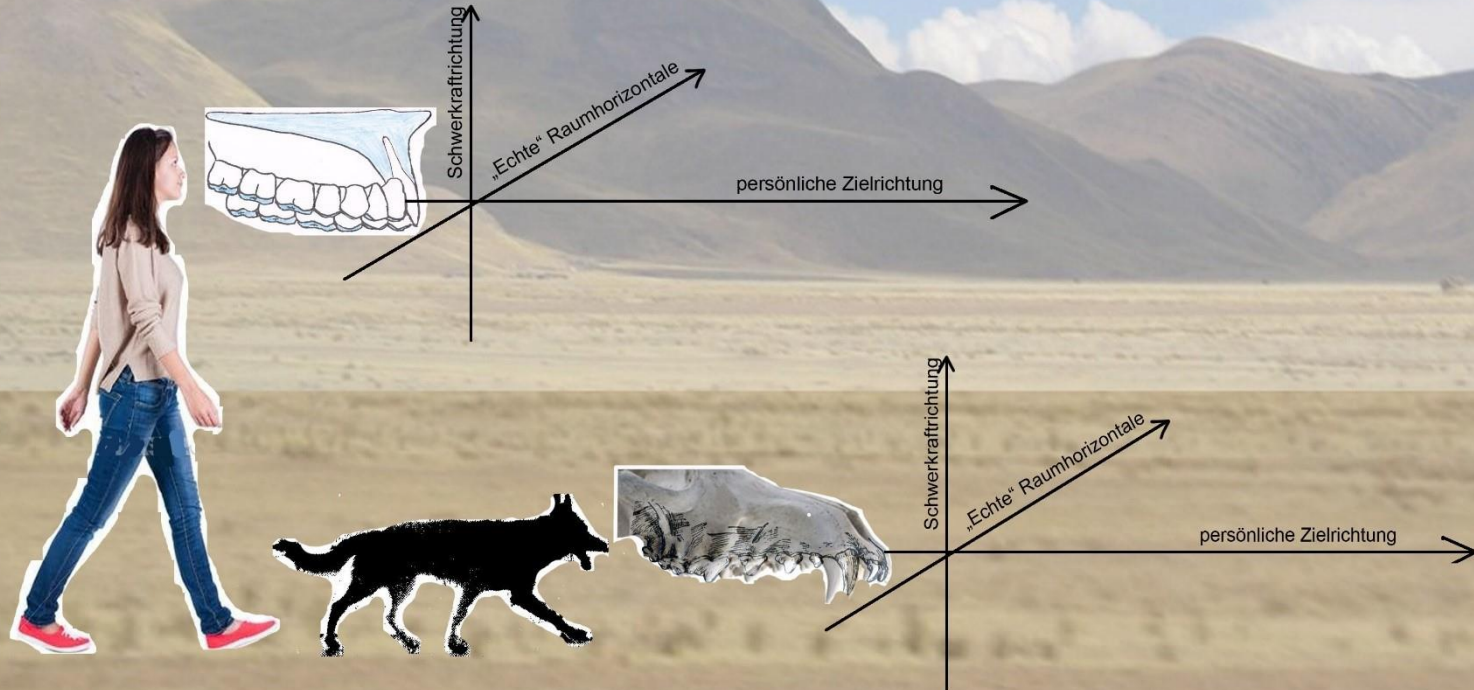
Orientation control system

Does spatial orientation function via an interface space between inside and outside located in the skull, identical to the (outer) spatial planes?

Is this body and environmental space defined by the axes of the maxillary chewing surface?

Tooth changes with inclination of the maxillary chewing surface could lead to postural changes and back pain.

Model of physical synchronisation with the environment



after "Baseline Of Upper Teeth

<https://doi.org/10.1016/j.mehy.2019.109391>

Copyright of the images by elsevier-Verlag

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

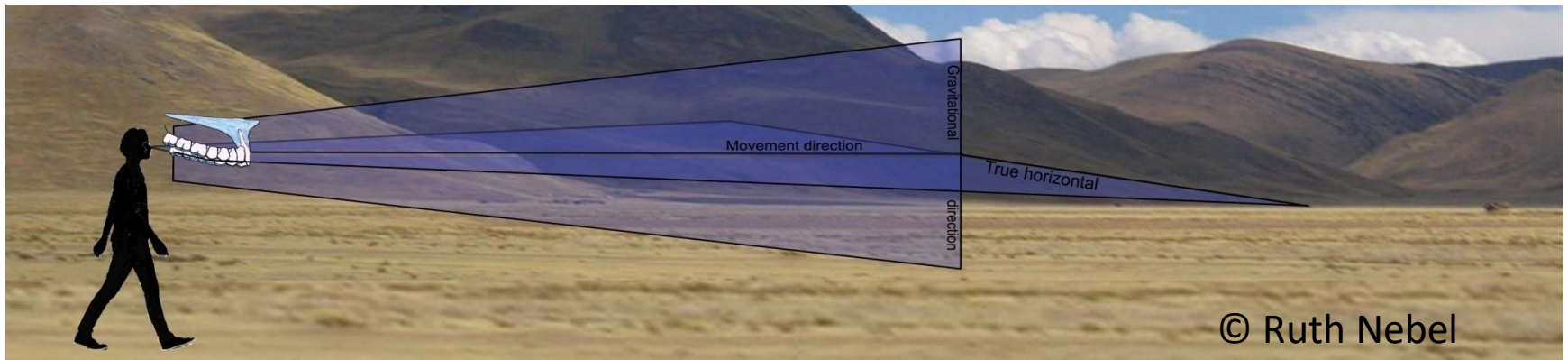
Anne Kapp^{a,*}, Marianne Paethke^b, Manfred Baqué^b, Ruth Nebel^c

^a Independent Researchers, Christstraße 36, Berlin 14197 Germany

^b Independent Researchers, Kreuznacher Str. 66, Berlin 14197, Germany

^c Independent Researchers, Steinhilberweg 8, Berlin 14197, Germany

References please see Baseline of Upper Teeth



Postural weaknesses, back pain, dental changes - is there a connection?

With chronic, severe back pain, you often see postures like:

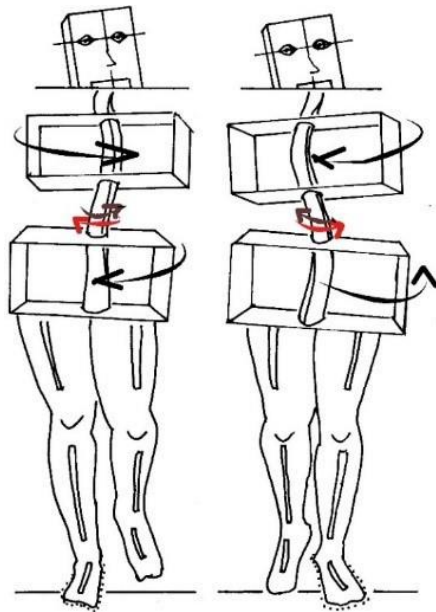
- Shoulder girdle far back, pelvis in front ("hollow round back")
- Head sideways tilt + shoulder drop

Sections of the body twisted, tilted and arranged offset to each other



Could the "postural weaknesses" possibly be expressions of a **function** pursuing an essential goal?

- Opposite rotations between thorax and pelvis - expression of a function?



- High price: rotations cause massive shearing forces on the lumbar spine, often resulting in pain
- What is the aim of these rotations?



Yes! The "postural weaknesses" are vital functions!



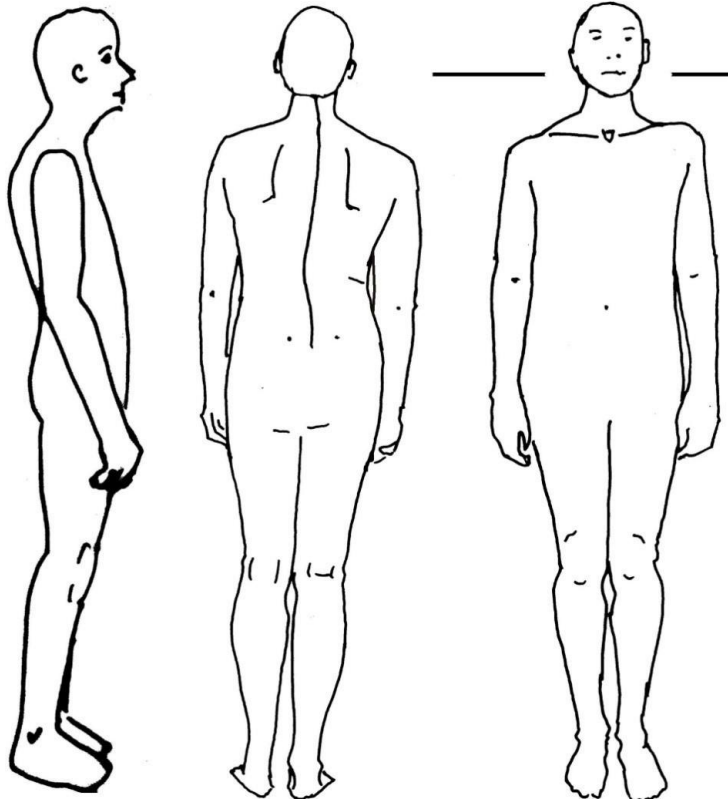
From "Parallel existence of dysfunctions in dental situation, jaw position and function, and posture of head and body", Manual Medicine Springer 2017 (DOI: 10.1007/s00337-017-0321-1).

Is the localisation of a certain structure within the head responsible for postural weaknesses?

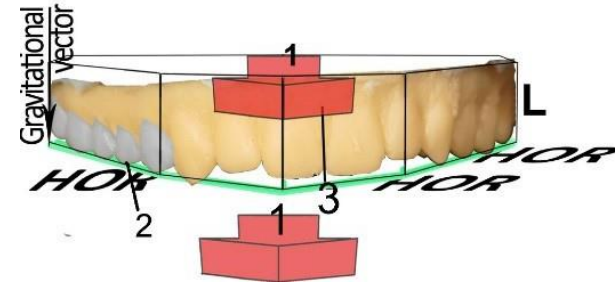
Our initial observation was a dental patient who was getting a new dental bridge comprising 5 teeth (maxilla): we provided two bridges in order to choose the best one. One of them was flatter, the other was higher. Applying the flatter bridge, the patient's head bended and the shoulder lowered. Applying the higher one, head and shoulder became upright again. The patient did not notice the change of her posture.

Extended tests suggested it might be the position of the maxillary chewing surface relative to the head. This followed the observation that it was the maxillary chewing surface which adapted to the true horizontal.

Consequence of a maxillary chewing surface that is positioned oblique to the head



Frequently occurring posture with the upper jaw chewing plane rising obliquely to the right and behind.



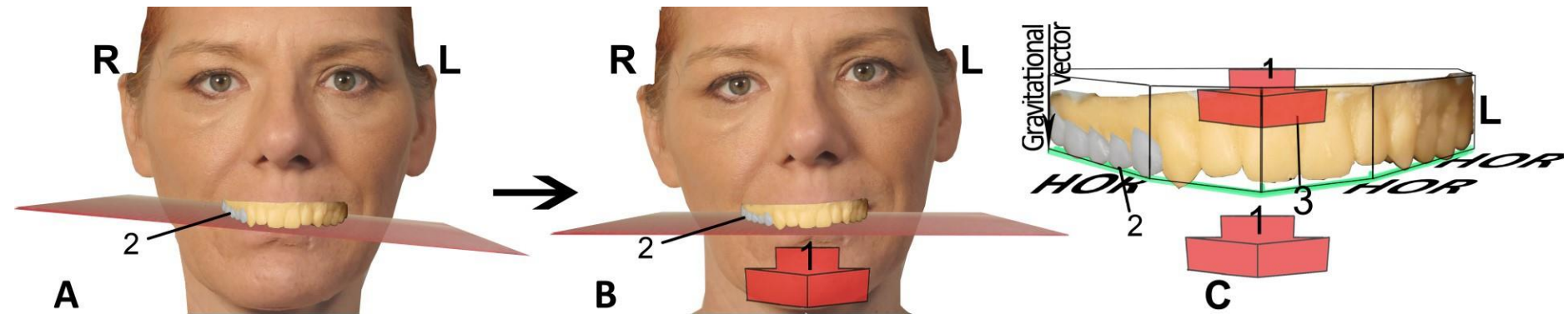
Because the maxillary chewing surface is necessarily aligned horizontally in space and with its depth plane in the direction of vision, its oblique position in the skull leads to an oblique head and altered posture. This is the case in about 80% of people, because the position of the maxillary chewing surface can easily be changed: tooth loss, height-changing dentures or orthodontics can change the position of the maxillary chewing surface in relation to the skull. It is decisive for the involuntary ("automatic") posture where the spatial-horizontal reference plane to the skull runs.

How is the maxillary occlusal surface aligned with the skull?-

Test with cheque card!

If you hold a cheque card or similar from below against the upper teeth, it shows the position of the upper masticatory surface. Ideally, it should be parallel to the axis of the eye. It is easy to slant the maxillary occlusal surface towards the head: crowns or fillings that are too flat (here on the right side of the face) cause the maxillary occlusal surface to rise towards this side (distance to the eye becomes smaller). Stick a piece of chewing gum to a maxillary tooth and then put the cheque card back on: it will then be at an angle to the head, on the side of the chewing gum it will be lower.

In real life, such a slant can happen due to tooth loss, fillings, bridges or orthodontics.



View when the bridge is too flat on the upper jaw on the right (2). The head immediately tilts to Align the maxillary occlusal surface horizontally again.

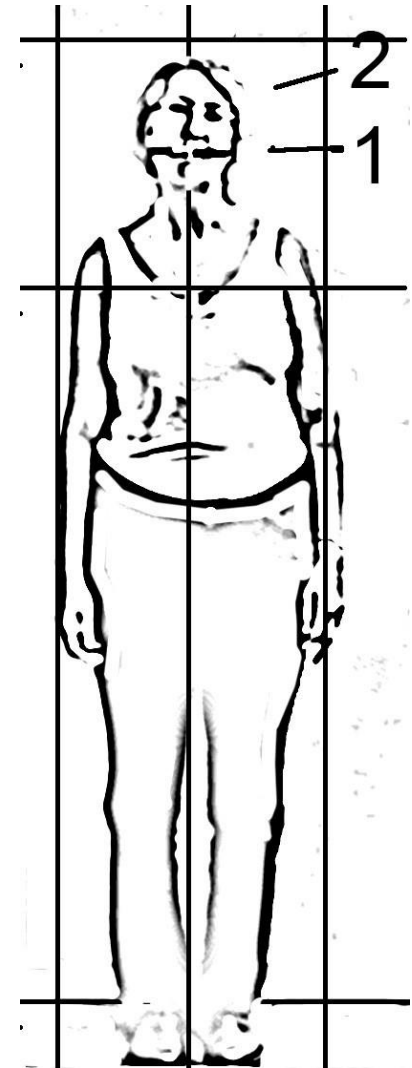
The maxillary chewing surface - aligned to the environmental space

1. Observation: the maxillary chewing surface remains in the same orientation to: gravitational direction, true horizontal, the target.

2. A high price is paid for this: when walking, the *shoulder girdle, pelvis and legs* rotate, tilt and shift *against each other*. They no longer stand straight on top of each other, but shift, tilt and rotate like an *eccentric crank*. However, in this way the horizontal alignment of the maxillary masticatory surface with the external space is established. In view of the high price, the alignment of the maxillary masticatory surface must be a superior function.

That may be the reason why these painful "Postural shackles" cannot be abandoned. They are resistant" to the *therapies used so far*.

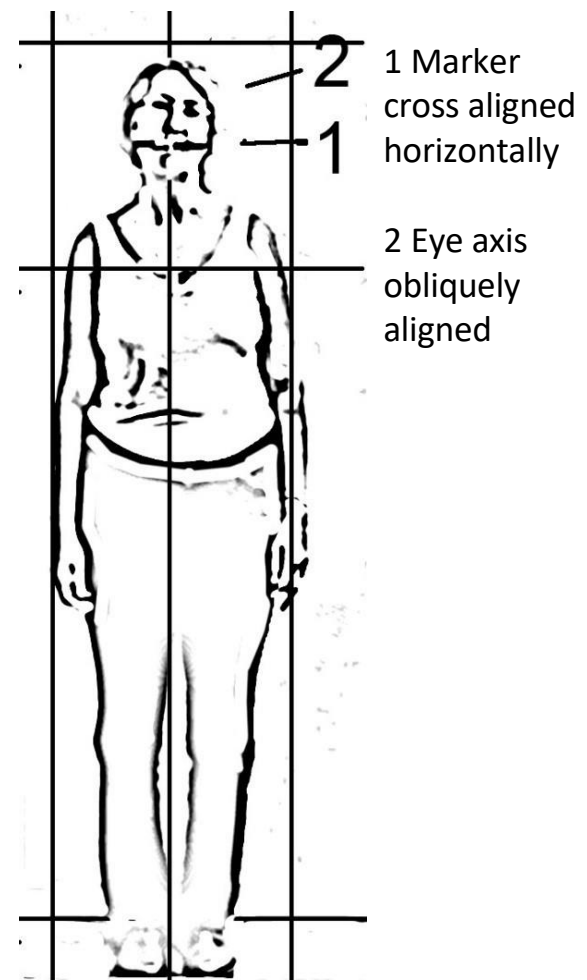
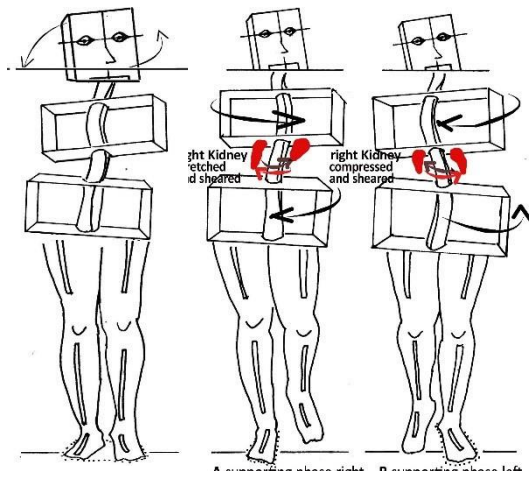
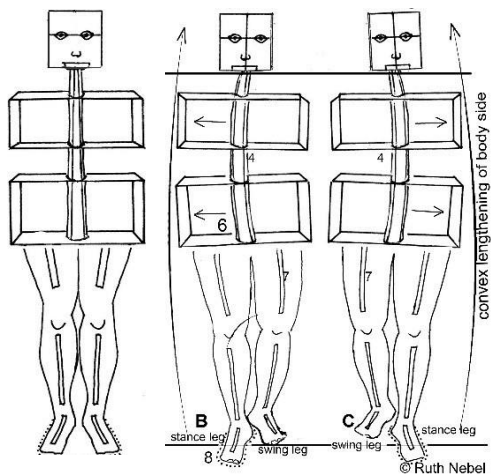
3. Attention: The alignment is valid for "automatic" walking. If you arbitrarily look to the side, the marker cross leaves the automatic alignment.



Postural weaknesses may have a goal: a certain structure of the head must be aligned with the outside world:

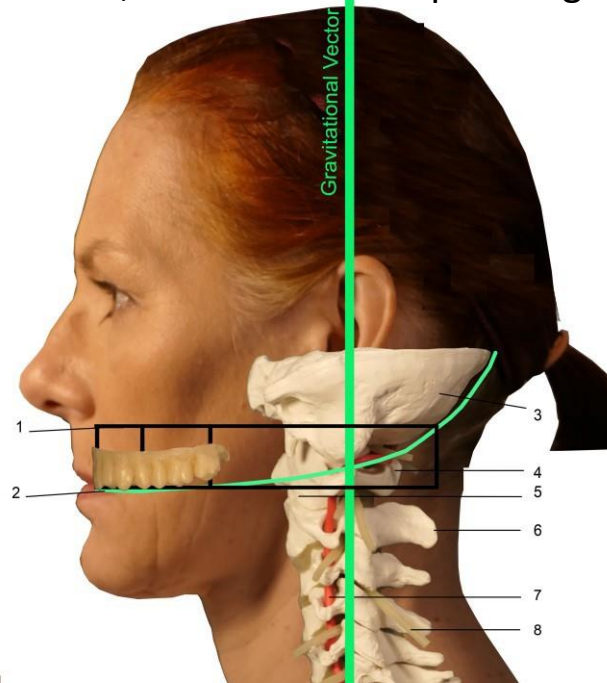
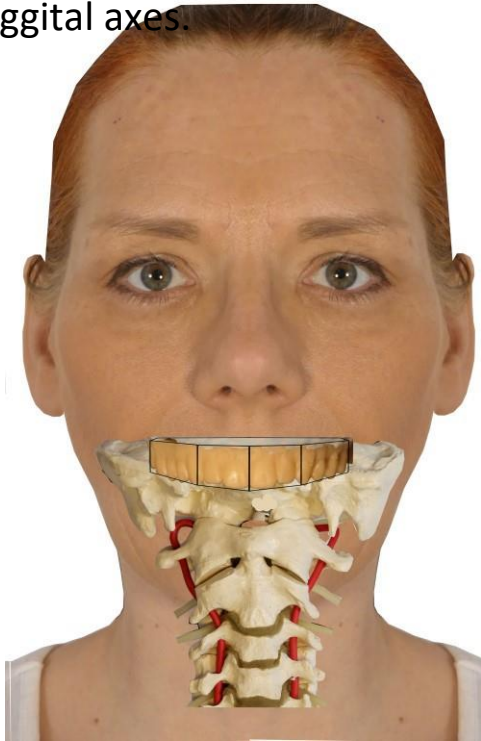
In each phase of movement, the maxillary chewing surface (in mosquitoes: maxillary mouthparts) remains positioned identic to the external spatial dimensions (gravitational force, movement target). The orientation of the maxillary chewing surface seems to be a prerequisite for spatial orientation.

Maxillary chewing surface transversal Maxillary chewing surface tilted to right orbita



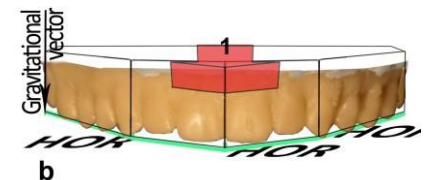
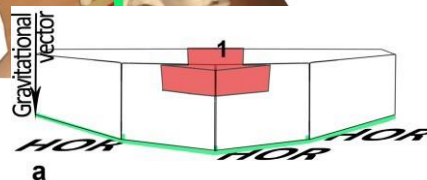
How does the position of the maxillary chewing surface influence the head posture (NHP)? Version 1: original teeth

The maxillary chewing surface is the only plane of the body that remains aligned to the gravitational direction, the true horizontal and the movement goal. Therefore, it's position relative to the head is crucial. This pic shows the maxillary chewing surface in a good position. Please note head posture (NHP) and the cervical spine. The following pic shows a change in head posture after a too flat maxillary bridge. We hypothesize a rectangular space above the maxillary chewing surface. If the maxillary chewing surface is transverse to the head, the axes of this space align the heads transverse, longitudinal and sagittal axes.



- 1) Environmental space in the head
- 2) Upper jaw purchasing surface
- 3) Okziput
- 4) Atlas
- 6) Axis

Rectangular space above the maxillary chewing surface:



Version 2: A too flat bridge produces a change in the normal head posture (NHP)

To the patient's upper jaw, a too flat bridge was applied in her right side. Consequently, the maxillary chewing surface is oblique to the head (approximating the right orbita) (**Fig. A**). Although oblique to the skull, the maxillary chewing surface is again aligned spatially horizontal. This is performed through changing the head posture (NHP changed). **Fig B** shows the position of the rectangular space above the new maxillary chewing surface. The axes of this space are no longer congruent to the head's axes. To align the maxillary chewing surface and the rectangular space, the normal head position (NHP) changed. The course of the cervical spine, changed, too. Now, only the rectangular space and the maxillary chewing surface are aligned upright. The body is no longer upright.

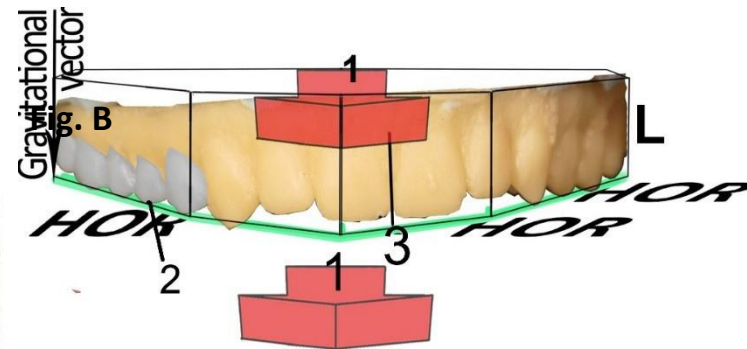
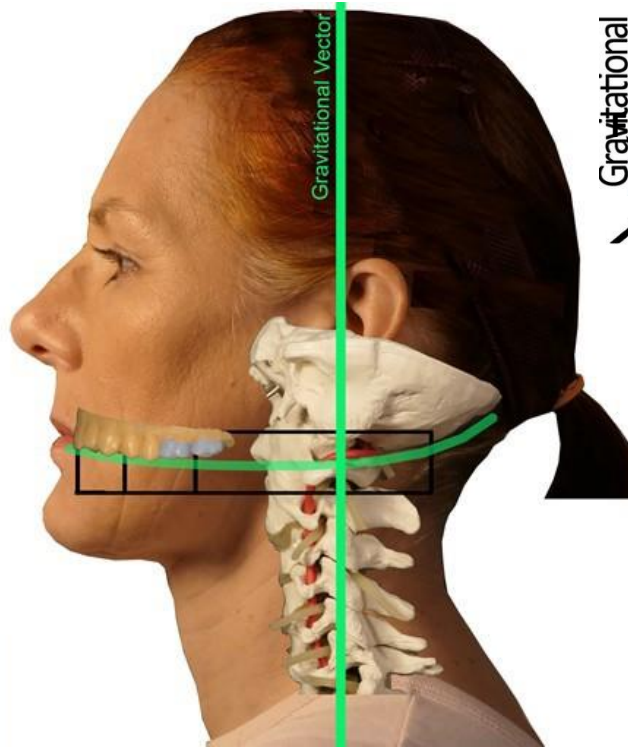


Fig. B: Rectangular space, sitting on the oblique maxillary chewing surface

- 1) Personal target direction (arrow) = no longer identical with the centre of the face;
- 2) Bridge too flat; 3) Centre of the incisors, no longer identical with the target direction; 4) Direction of gravity, no longer identical with the axis of the head.

A tilted maxillary chewing surface has got a high prevalence

If the maxillary chewing surface is tilted towards the skull (due to tooth loss, fillings, crowns), the head immediately (within 2 minutes) tilts as in these portraits. The tilted head posture is so common that it is no longer even noticed in other people's everyday lives.

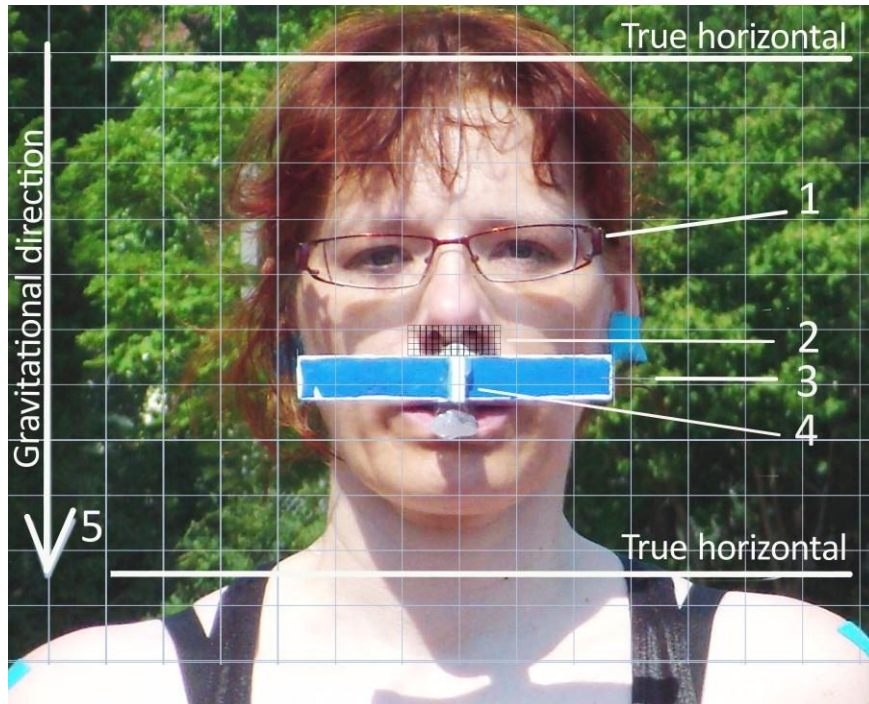
Incidence of oblique maxillary chewing surface : 70-85 % of people >30 years.



Test in front of the mirror: Tilting the maxillary chewing surface to the skull

- Test: The displacement of the maxillary occlusal surface is possible through almost any material, which can vary between upper and lower teeth is placed.
- Experiment with cardboard strips (experiment in front of the mirror): A piece of 3 cm long, 3 mm thick impregnated cardboard, placed between the upper and lower teeth of one side, loosely closed.
- The lower surface of the maxillary teeth as perceived by the body is thus shifted 3 mm caudally. Reaction: Within 30-60 sec. the head is raised on this side and tilted to the other side until the new occlusal surface lies on the spatial horizontal. There is a corresponding change in posture. This continues as long as this splint/cardboard remains between the teeth.

We present **The marking cross** to make the position of the maxillary chewing surface visible.



- 1) Eye axis
 - 2) Environmental space in the head
 - 3) Marker cross, connected to the maxillary occlusal surface via a wire and a dental splint, indicates its position in front of the mouth
 - 4) Wing pointing to the personal target (front side)
 - 5) Gravity direction / "true" horizontal
- Typically, the neck runs in the opposite direction to the head tilt.

Is the eye axis straight? - No! The maxillary chewing surface is primarily aligned

If the maxillary chewing surface is at an angle to the head, then the head is tilted in a compensatory manner in order to nevertheless place it spatially horizontal. This means that living beings focus with the maxillary chewing surface, but not with the eye axis.



Television address by the German Chancellor: the head is tilted to her left side and rotated to her right side. The right eye is thus turned away from the focus of the camera. The gaze line to the camera is slanted, the pupils are angled. Hypothetically, therefore, the focus is not on the eye axis but on the maxillary chewing surface. If the maxillary chewing surface is very crooked, angle squinting can occur.

Test 1: Remains the incorporated environmental space spatially consistent even during movement ?

We investigate whether the maxillary chewing surface remains spatially consistent during walking, running and jumping:

Setting:

A marker cross is attached to a maxillary splint by means of a wire, which sits stably on the maxillary teeth. It stands in front of the mouth and indicates the position of the maxillary chewing surface. The marker cross has wings arranged at right angles, of which only the white transverse wings are visible in the picture. The blue wing points in the direction of travel, i.e. towards the camera. As long as the blue wing does not leave its position towards the camera, only the front side is visible.

In the test, the subject walks, runs or jumps towards the camera. His direction of movement therefore coincides with the camera focus.

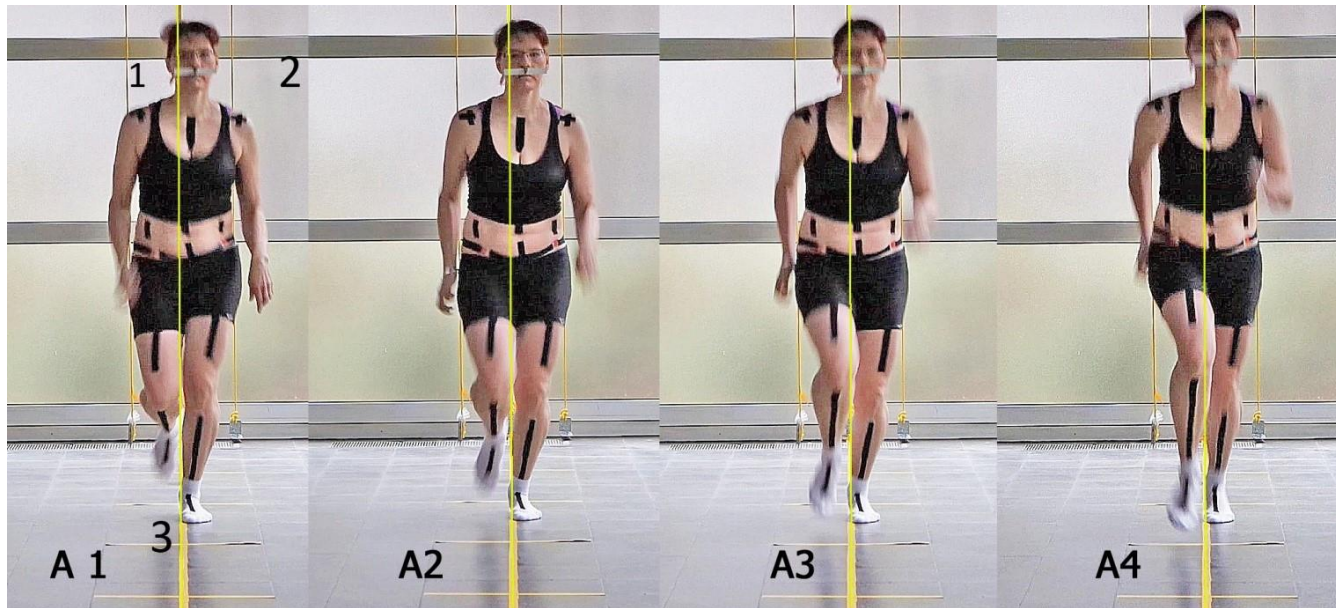
Research question:

We evaluate the position of the marker cross in relation to the environmental space: does the marker cross remain spatially consistent in each movement phase?

Do the shoulder, pelvis, knee and foot levels behave similarly?

This investigation benefits from marker-based motion analysis such as Vicon-3-D.

Test 1: The marker cross remains constant in space during the automatic locomotion in the environment



First impression: As the test person walks towards the camera, the marker cross remains directed towards the goal and spatially horizontal. This is remarkable because all other levels of the body change their position in relation to the space.

© Ruth Nebel

Test 2: Will an oblique chewing surface be aligned spatially consistent, too?

An interventional test is performed, whether the maxillary chewing surface and the marking cross again remain spatially consistent during locomotion. The first, initial round is without intervention. In the second, interventional round, an oblique maxillary splint is applied. This splint is flat in the right and thick in the left side. Presupposition: any material in touch with upper teeth and jaw is perceived as "maxillary chewing surface" - the reference of body posture.

Setting

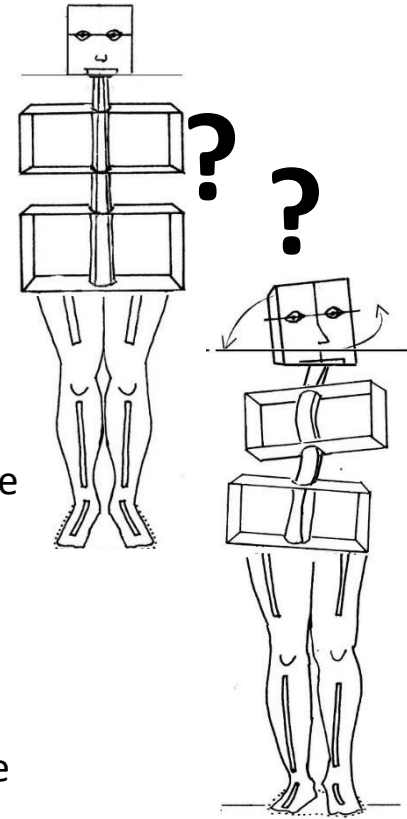
First round: The subject moves with an almost transversal maxillary chewing surface (indicated by a marker cross). He runs and jumps towards the camera.

Second round: The subject inserts the side-inconsistent splint. There is a 3 minute wait. Then he runs and jumps towards the camera as in round 1.

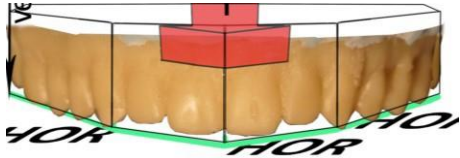
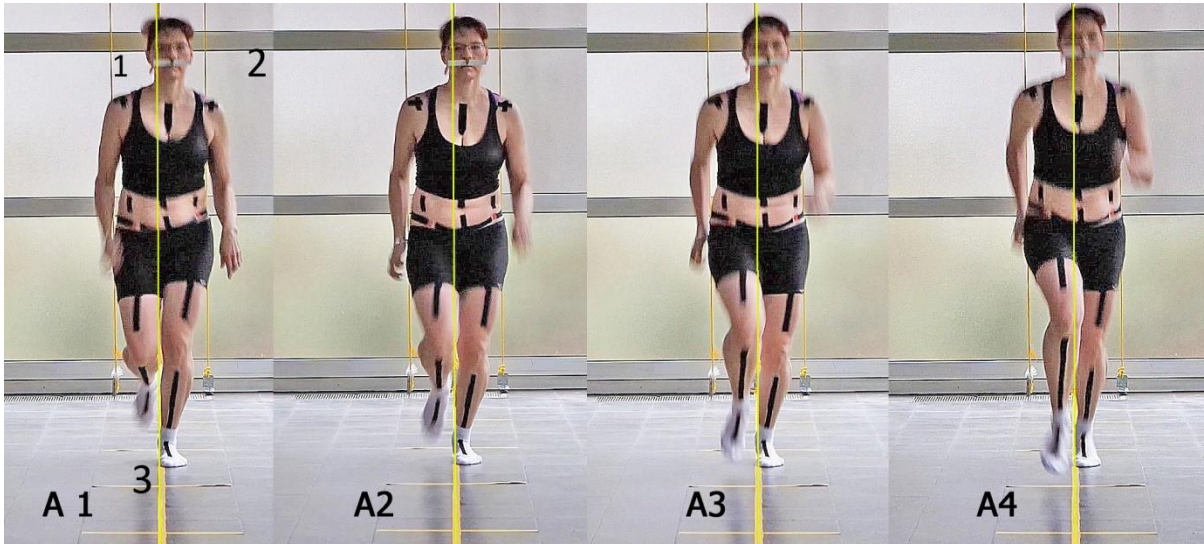
Evaluation

Research question: Does the marker cross remain spatially consistent in both versions? Do the head, shoulder, pelvis, knee and foot levels behave similarly in the initial round as in the interventional round? What is the impression regarding functionality initially and after the intervention?

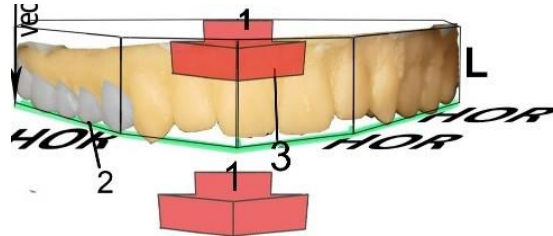
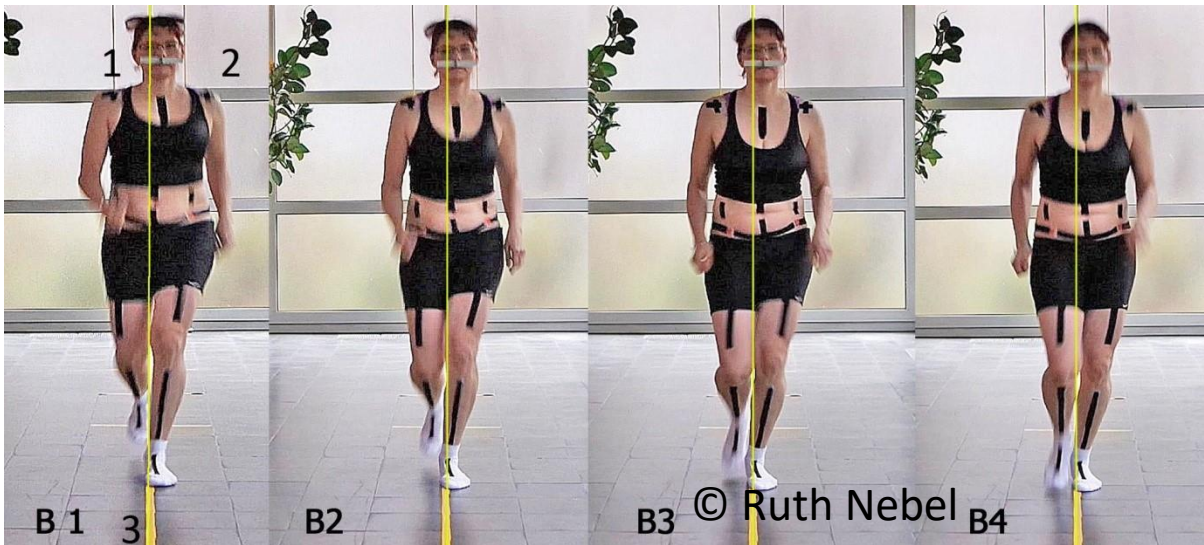
Professionally, this test would be carried out with a marker-based movement analysis (e.g. Vicon-3-D).



Test 2. running: Spatial consistency of the transverse maxillary chewing surface vs. that of the oblique maxillary chewing surface

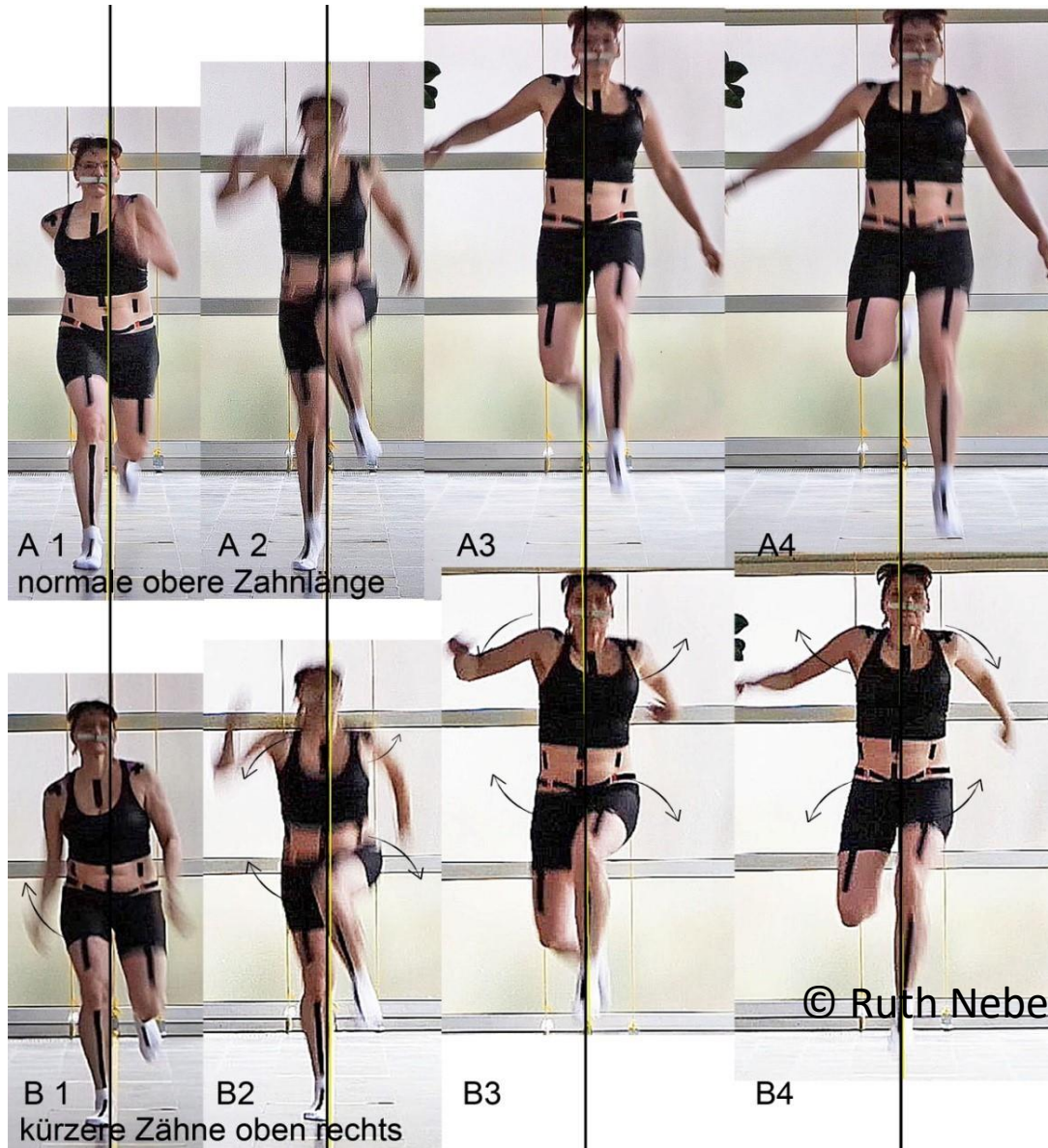


In upper row A, the maxillary chewing surface is relatively straight to the skull and walking appears to make functional sense.



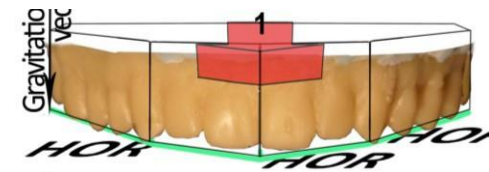
In the lower row B, the maxillary chewing surface is tilted up to the right and back of the head. The head is tilted to the right side. When walking, the body sections are twisted against each other. The trunk buckles. The movement appears dysfunctional.

Test 2. jump: Spatial consistency of the transverse maxillary chewing surface vs. that of the oblique maxillary chewing surface

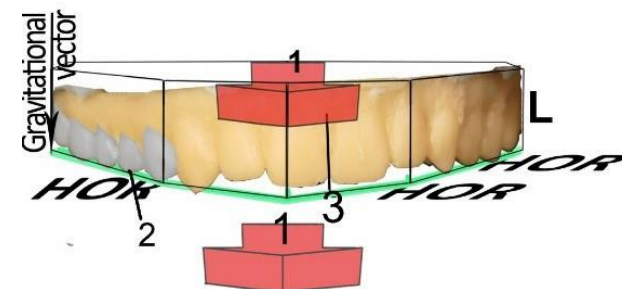


Top row A:

Jump with relatively straight maxillary chewing surface.



Bottom row B: Jump with maxillary chewing surface rising to the right. Sections of the body twist against each other, the torso buckles.



Evaluation of the study

Result

First (initial) round with straight maxillary chewing surface: The marker cross remains constant in space while all other body planes swing, rotate and tilt a little. The movement appears functional, the body's centre of gravity is "hit" by the respective accelerating leg and can implement the acceleration.

Second (intervention) round with maxillary chewing surface oblique to the head : The medullary cross remains constant in space while the other body planes clearly rotate against each other, swing strongly back and forth, tilt strongly and shift out of the longitudinal axis of the body. The acceleration of the jumping leg does not "hit" the torso and fizzles out in opposite rotations. However, these do not serve the movement. The force cannot be converted. The movement appears dysfunctional.

Interpretation

This suggests that the maxillary chewing surface remains spatially constant even during violent movements, while all other body planes do not. Movements with the maxillary chewing surface at an angle to the head appear dysfunctional and unergonomic, so that a loss of performance is to be assumed.

	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, thrusts 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 oppositely, 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

Regular autonomous postural patterns depending on the position of the maxillary chewing surface relative to the skull.

Dictionary:

Extension: head in neck

Mandible: lower jaw

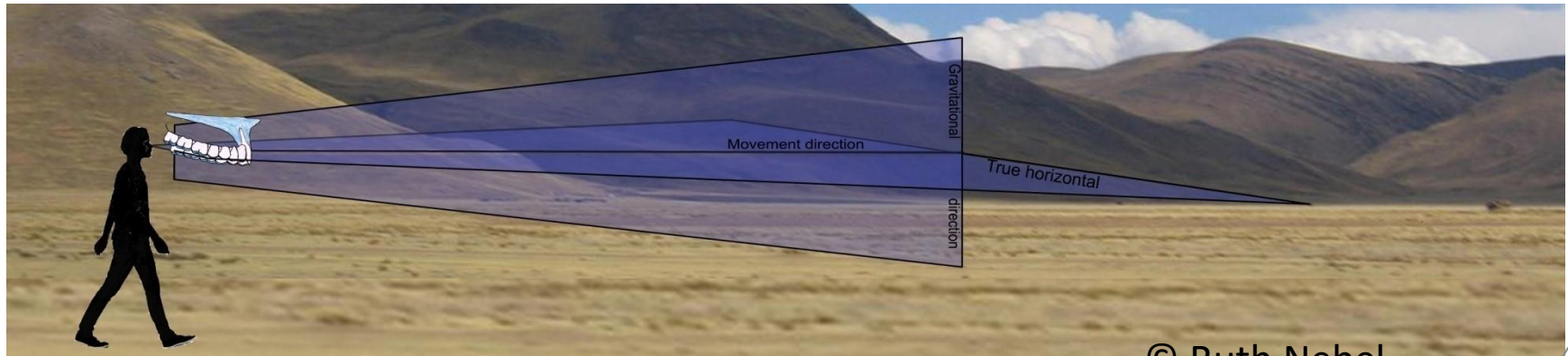
Dorsal: behind

Ventral: front

The maxillary chewing surface - superior reference plane of spatial orientation?

Spatial orientation has so far been understood as the sum of individual sensory impressions: According to the conventional thought model, countless (individual, quasi-independent) sensory impressions are transported from the periphery to the central nervous system and processed. Consequently, adequate motor reactions are generated. It, too, is composed of countless (individual, quasi-independent) motor impulses.

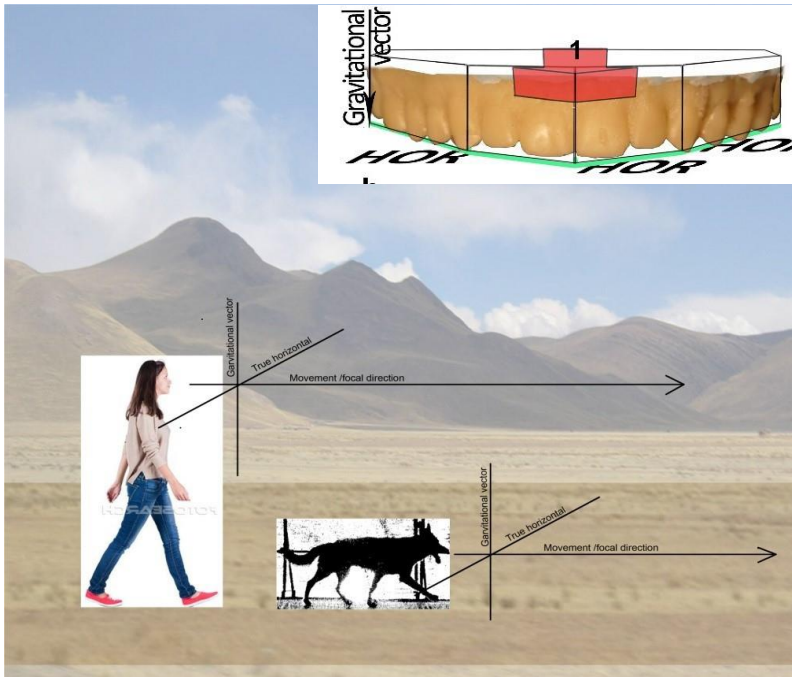
Scientists criticise this model because this information processing takes much longer than an equilibrium reaction. An alternative model of spatial-vector processing is presented here. This is because the processing of individual impulses is not necessary for equilibrium reactions: Equilibrium reactions are not individual and not arbitrary. They are ultra-fast, automatic, unanimous, follow law-like patterns and occur simultaneously over the whole body. (This makes them distinguishable from voluntary movements). In the following, a model is presented that enables unanimous adaptation of the entire body to the environment.



The environment in one's own head

In the model presented here, the living being is hypothesised as part of the environment. Because it carries the environmental space within itself, it is a part of the environment and not an observer. The living being acts, changes and is also changed by the environment. It therefore interacts instead of only perceiving unilaterally. In this model, processing of vectors is assumed: Vectors of motion and gravity. This vectorial processing hypothetically takes place in the space above the maxillary chewing surface. It is physically related to the individual and their target. The physical vector space hypothetically serves as the interface between the environment and the individual. Its axes represent the main vectors:

1. One's own direction of movement, thus also: one's own "forward", basically horizontal.
2. Gravity is at right angles to the direction of movement, vertically. It is a variable that must be constantly calculated for all living beings.



One's own movement must be adapted to gravity and the target in each movement phase. All other vectors are represented in the framework of the vector space for gravity and the movement target. Hypothetically, this physical-graphical system allows all movement vectors to be calculated with a hitherto unexplained speed. In this vector space, the effect of gravity and the movements of environmental objects are also shown (= other people, flying balls).

Balance reactions: The body's fastest motor reactions to adapt to the environment

Balance reactions, also called postural or positional reactions, are involuntary, automatic, predictive, intelligent and ultra-fast reactions of the body. They find the best position of the body in relation to the environment. In our model, they are additionally anticipatory/planning and process the current needs of the individual.

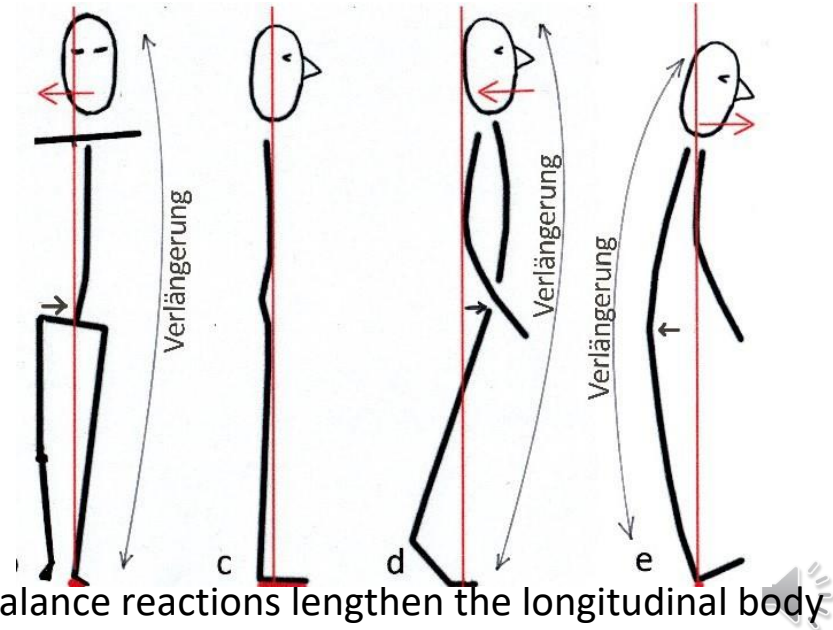
Due to their special characteristics, they can be distinguished from voluntary motor activity. They run in lawful patterns. They are ultra-fast.

They happen involuntarily, often unconsciously.

They occur simultaneously on all areas of the body.

Balance reactions lengthen the body segments, that have contact with the support surface (floor). This works primarily mechanically (see picture).

If the maxillary chewing surface is straight in relation to the skull, then bones are loaded in their longitudinal axis during balance reactions. There are no shear forces or incorrect loads.



Balance reactions lengthen the longitudinal body segment, which is in contact with the support surface.

Benefits of synchronisation with the environment

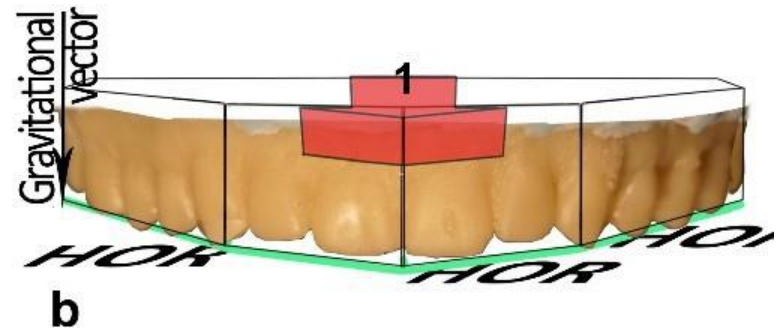
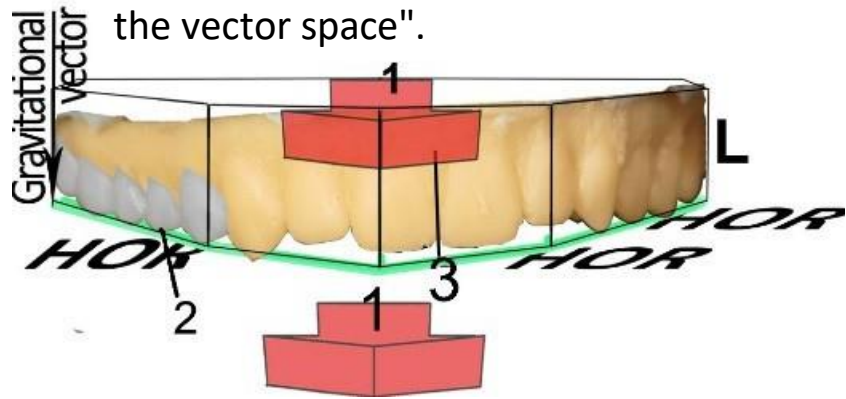
Living beings have an exact relationship to their environment. That is why they can move in it, avoid obstacles, estimate distances and grasp objects. They always know how they relate to gravity. They know the ground they will walk on in the next 5 steps. They unconsciously decide whether they will cross in *front of* or *behind* another person or car. They even adjust their step length or speed to an obstacle several metres in advance. Living beings deal with the environment as intimately as if it were part of them. This is exactly what seems to be accomplished with the common inner and outer space: They are part of the environment and the environment is part of them. **Their own space expands from the maxillary chewing surface into the environmental space. At the same time, the environmental space folds into the maxillary chewing surface. Body and environmental path are in the same system. So every step on the environmental path becomes predictable with hollows and stones.**

Humans and animals (migratory birds) have a piece of environmental space with a goal and spatial dimensions in their heads. Probably only through this commonality is it possible for carnal beings to orient themselves in their abstract environment. Only in this way is the environmental space perceivable as three-dimensional. No experience of a spatial environment could arise from two-dimensional visual impressions alone. This sense of space is supported by the visual function, but does not depend on it. Blind people also have the perception of a three-dimensional space in which they complete paths and overcome obstacles.

A physical structure as an interface between inside and outside: A vector space within the head

We assume that the rectangular space on the maxillary chewing surface serves for the calculation of vectors. Its plastic framework is the basis of spatial orientation: the axes and "Walls" of environmental space represent the most important vectors for the living being: The direction of gravity and the direction to the personal goal. (Visual) sensory and sensitive impressions are inserted into this vector framework. The spatial-vector representation allows the lightning-fast calculation of one's own vectors in relation to the vectors of environmental objects and gravity. Hypothetically, sensory impressions can only be spatially located and related to the subject after insertion into the vector framework. From this spatial localisation, a three-dimensionality emerges again from two-dimensional visual impressions. Next page: "viewpoint of

the vector space".



Picture a and b: Vector space is on oblique and straight maxillary chewing surface. The lower surface of the teeth is aligned absolutely spatially horizontal. The three-dimensional vector space (the environmental space) stands on top of it. 1) Personal target direction (arrow); vertical: gravitational direction/ vertical struts of the vector space).

Model of the viewpoint of the vector space. Presentation and calculation of vectors.

2. curb: one's own stride length is unconsciously adjusted so that one can take a good step down or up. This also happens when approaching stairs 5 metres before.

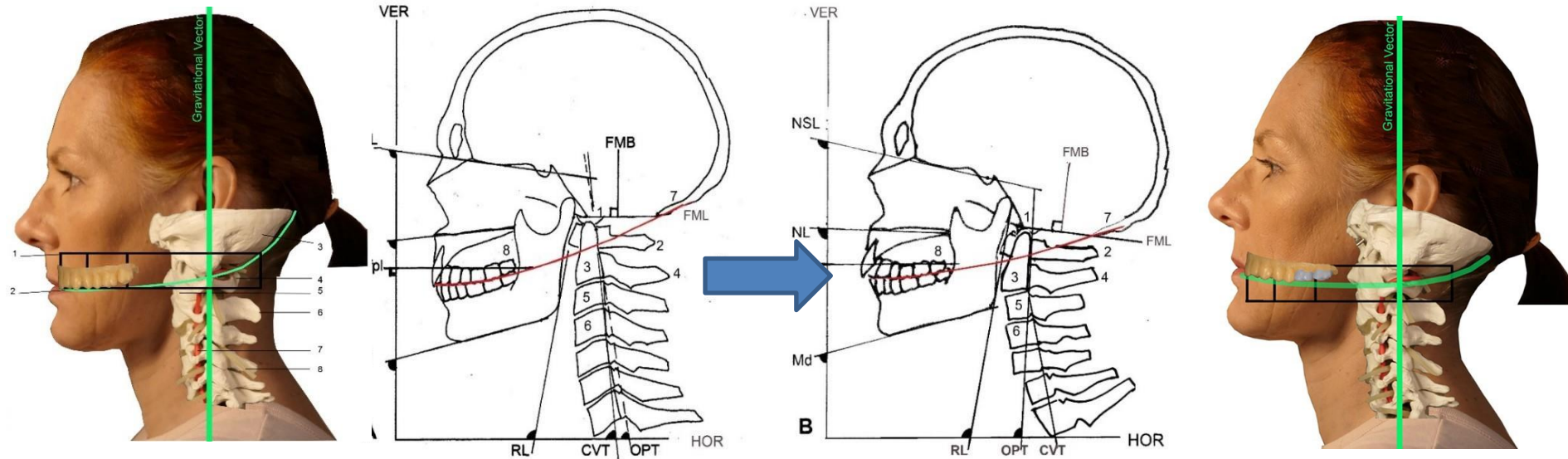
3. The dogs are desperate to meet. The dog rushing towards the other will get hold of the other's neck area with a jump from above.

4. The man crosses the path of the group of prams. Unconsciously, vector calculations run: whether he walks a little faster to cross in front of the group or a little slower to cross after it.

1. football boys: Football boys: Anticipation of the ball vector: to have already prepared one's own activity before kicking the ball back.



Conception of a stimulus-response principle. The maxillary chewing surface rising to the back head leads to a lowering of the back head.

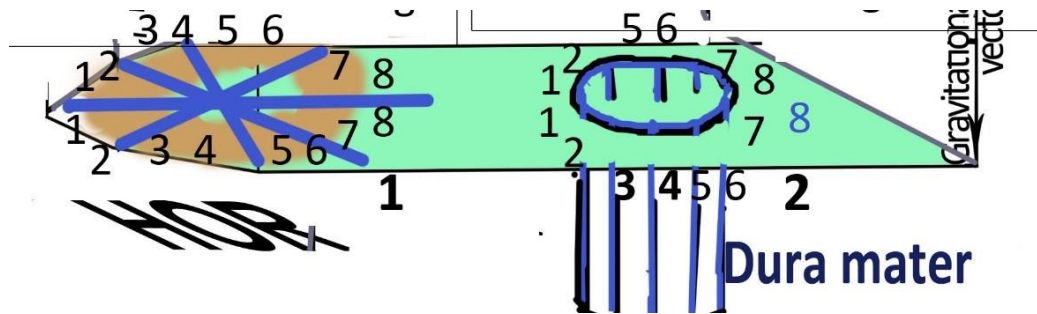


Initial situation with the maxillary occlusal surface transverse to the head. The maxillary occlusal surface, occiput and dura cross-section are in an absolute position in relation to the spatial horizontal. This determines the head posture (NHP) (= the respective unconsciously assumed head posture of the individual).

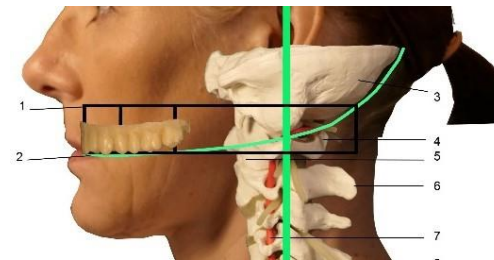
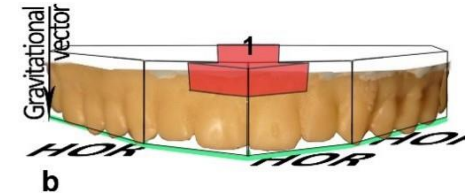
After teeth have been shortened at the back, the upper jaw surface rises backwards towards the skull -> the occiput lowers at the back, the head posture (NHP) changes: the head is tilted backwards. The first and second cervical vertebrae (atlas and axis) slip forward and tilt backwards. This causes the back of the neck to shorten. The spinous processes are now closer together. The bone tunnel, where the dura pulls down into the body, shortens.

Conception of a stimulus-response principle. Dura mater as ultrafast transferring structure

The dura mater (hard meninges) coats brain and spinal cord like a tube. We imagine this tube subdivided into 16 segments (as much as maxillary teeth). We hypothesize that the dura mater is the informing structure between vector space and body. We hypothesize that the information is mechanical to a great part. We hypothesize that it lies in the course and tone of the dura mater within the key region. The dural tube is forced into a certain course. The 16 segments are influenced in a different way. Tone, twist and buckling are passed to the deep muscles supplied by the single segments.



Mechanical principle of this coding: The maxillary masticatory surface and the cross-section of the dura mater lie on the same curved surface (green in the illustration). The cross-section of the dura mater (2) thus has the same (spatially consistent) position as the maxillary purchasing surface. The dura mater is thus also physically synchronised with the environmental space at the level of the skull base.



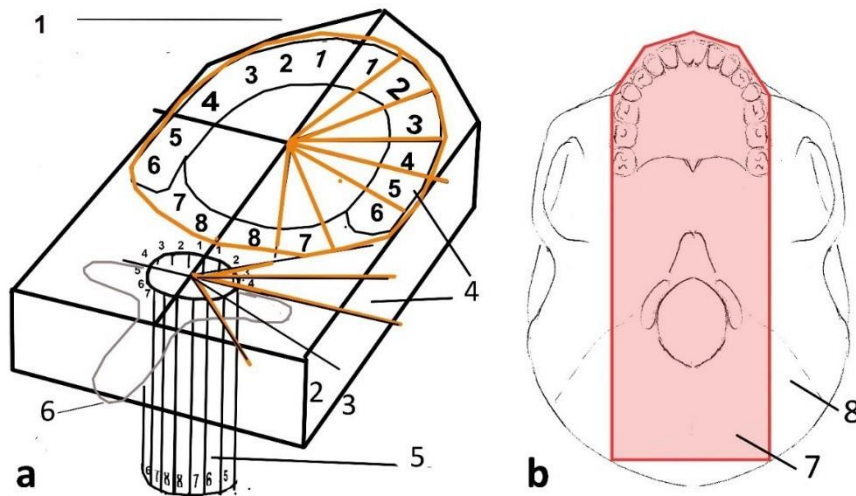
Reference plane,
anatomical view

- Coloured green: Base of the vector space;
- (1) Upper jaw purchase surface with tooth numbering;
- (2) Cross-section of the dura, durase segments in tooth numbering



Conception of a stimulus-response principle. Vector space with Dura mater.

The environmental space represents the body and the environment at the same time. This still requires a hitherto unknown anatomical feature: hypothetically, the maxillary chewing surface and the base of the skull always lie on a curved surface. Only in this way can the segments of the maxillary teeth (maxillary chewing surface) be connected to the longitudinal segments of the dura mater (dura mater: tube that envelops the brain and spinal cord).



b) 8) Skull from below 7) Pink: Position of the environmental space in relation to the skull, formed by the maxillary chewing surface and the occiput, here with a passage opening for the Spinal cord (Foramen Magnum)

a) 1,1) Tip of the space with maxillary anterior teeth (1,1)

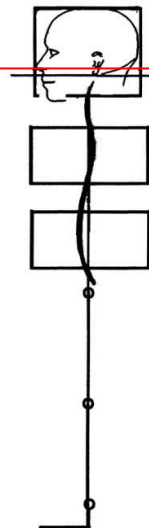
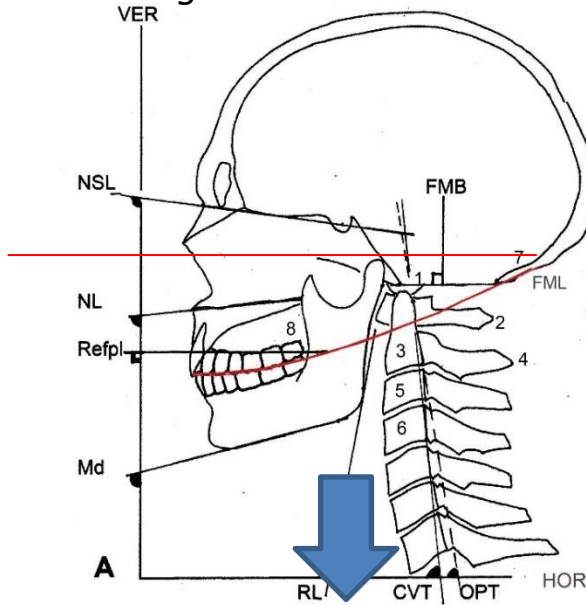
1) Gravity line, perpendicular to maxillary occlusal surface

4) Maxillary masticatory surface in 16 teeth(segments) correlating with corresponding segments of the dura (spinal cord sheath), 4) showing the pie slice-like view of the longitudinal segments.

5) Spinal cord with enclosure of the dura in longitudinal segments

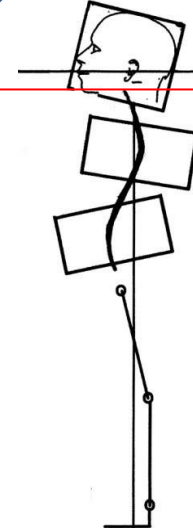
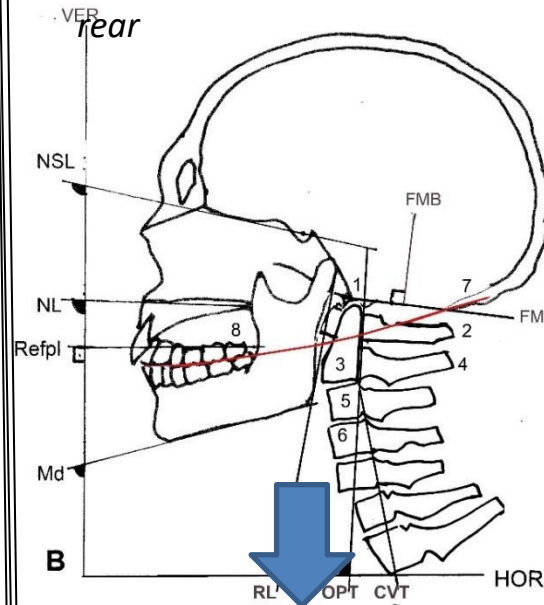
Conception of a stimulus-response principle. Maxillary chewing surface and the base of the skull form a common plane.

Head posture with straight occlusal surface



Posture with straight occlusal surface

Head posture with the upper purchase surface rising to the rear



Posture with backwards rising OK purchase area

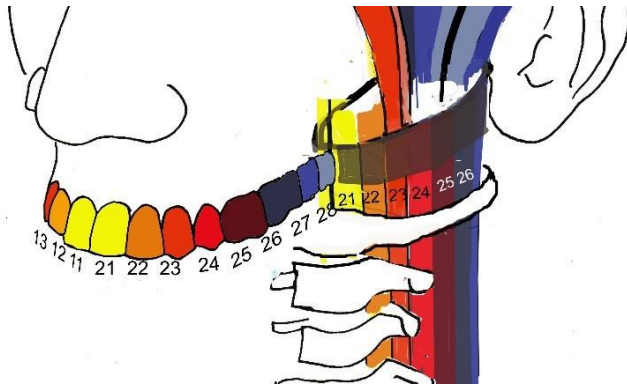
Red line: spatial horizontal

Conception of a stimulus-response principle. Transferring structure

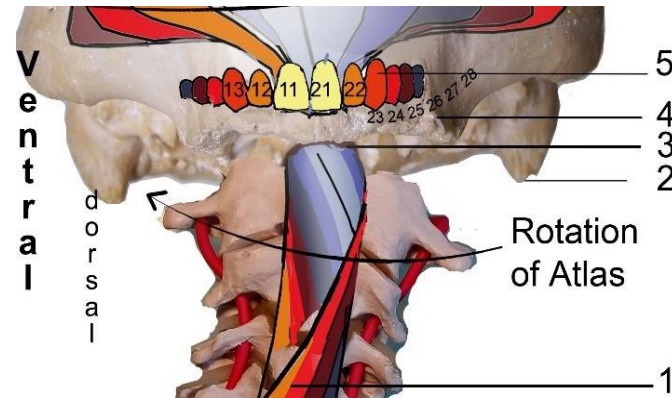
Dura mater kinked and twisted in the "key region".

The sensitive area for postural information seems to be the short stretch of the tube of the dura mater between the skull and the second cervical vertebra (C0-C2). As a special feature of this region, the joint partners are not connected by ligaments, but exclusively by the dura mater. Any change in position in this region is therefore not only perceived by the dura mater, but also changes its tension.

So we are looking for a segmental influence of the dural tube, corresponding to the segmental tooth numbering of the maxillary chewing surface. This could be the position of the dural tube in the area C0-C2. It depends on the head position and the position of the maxillary chewing surface.



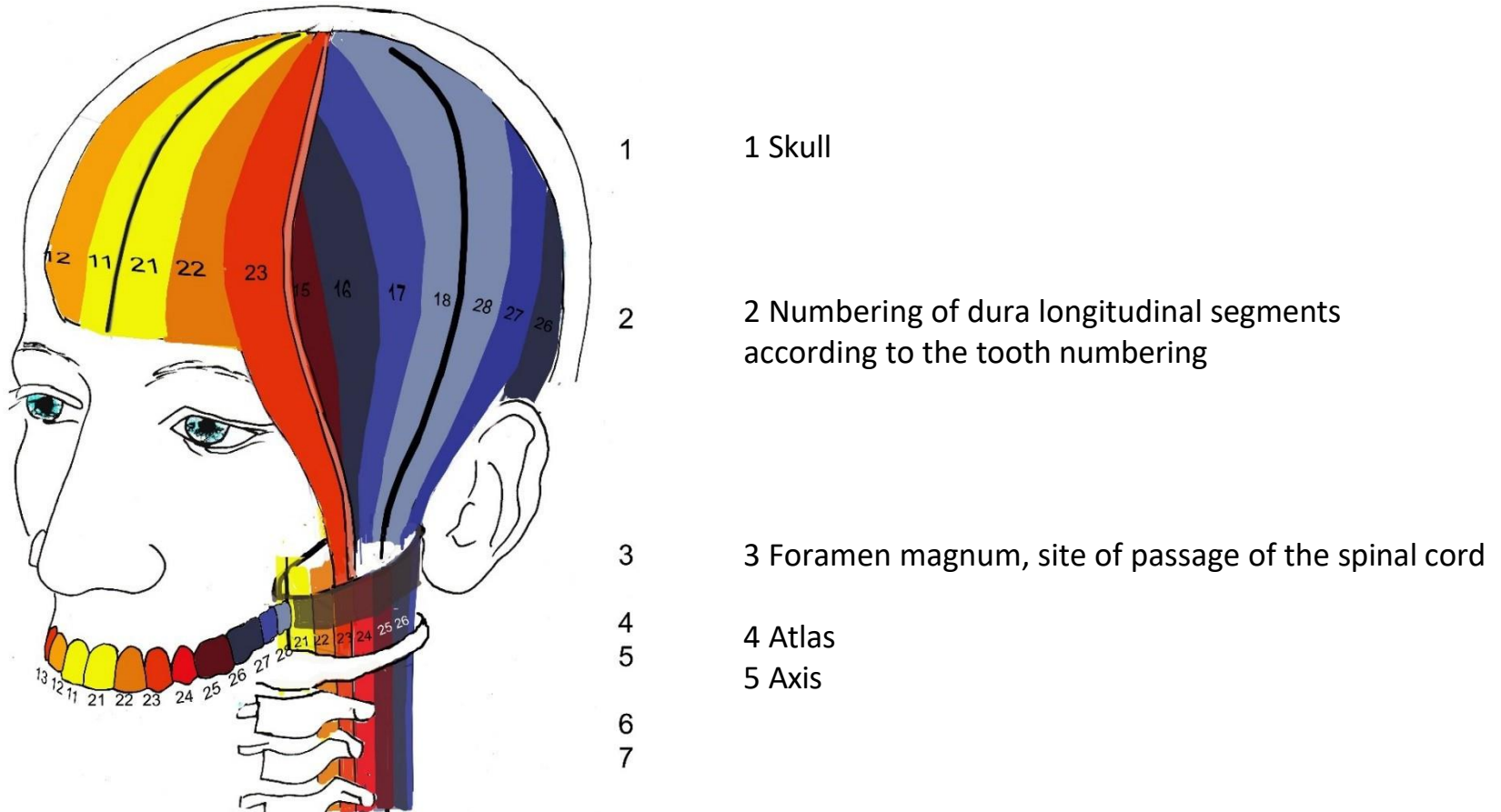
Region C0-C2 when the maxillary occlusal surface is straight to the skull: The dural tube runs straight and without twists, kinks or tensions



Region C0-C2, when the maxillary masticatory surface is oblique to the skull: The dural tube runs twisted and kinked. Its segments have different tensions.

Conception of a stimulus-response principle. Longitudinal segments of the Dura mater evenly toned

With the maxillary chewing surface in a straight line to the skull, all segments of the dura between the base of the skull and the second cervical vertebra are evenly toned. In this section, the dura carries a huge amount of positional receptors whose information travels directly to the spatial processing centres of the brain. In this section, all structures are connected exclusively by the dura itself; there are no ligaments between the structures. Changes in position are therefore detected directly by the dura.



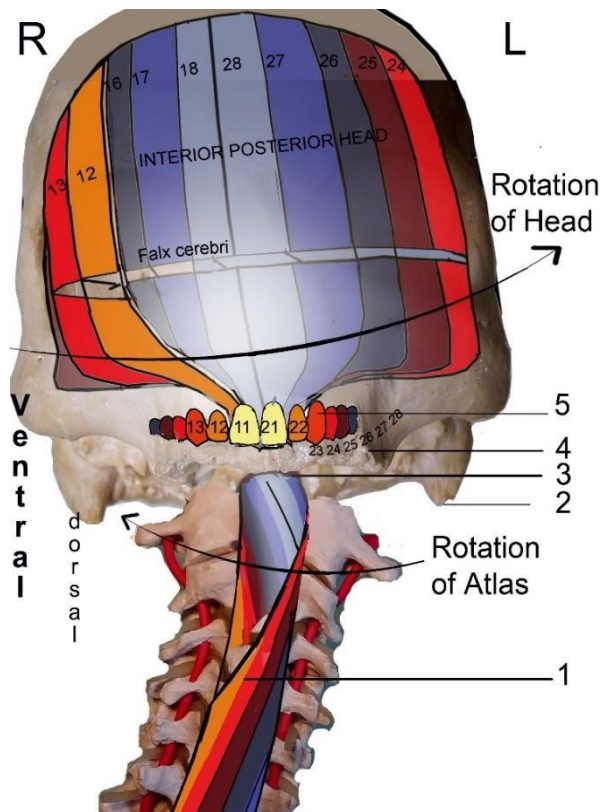
Conception of a stimulus-response principle. The longitudinal segments of the Dura mater are twisted and buckled

In this picture, the maxillary chewing surface is oblique to the skull, rising to the right (left in the picture), and also rising backwards. In order to place the maxillary chewing surface, occiput and dura cross-section (dura mater is the hard meninges) spatially horizontal, the head tilts to the right and back.

This compresses the dura in the area between the base of the skull and the second cervical vertebrae and twisted ("throws wrinkles").

The approximated longitudinal segments of the dura lose their tension and shorten. Twisting and length changes of the dura change the automatic posture.

Hypothetically, only the situation of the dura between C0- C2 (skull base, first and second cervical vertebrae) is decisive for this.



- (1) Longitudinal segments of the dura, numbered like the corresponding teeth. They are twisted between the skull and the 2nd cervical vertebra (axis) (=C0-C2); (2) Proc. Mastoideus; (3) Foramen magnum (passage of the myelon to the spinal column).
- (4) Base of skull, as obliquely displaced as the maxillary occipital surface.
- (5) maxillary chewing surface, rising towards the right eye, also rising towards the back. With numbering of the teeth, colours corresponding to the longitudinal segments.

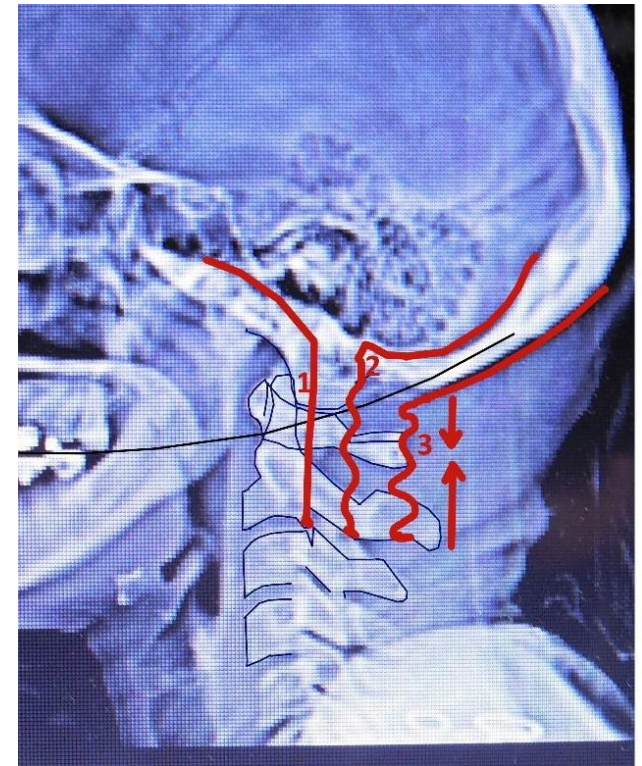
Conception of a stimulus-response principle. Maxillary chewing surface, Dura mater and posture

This would encode the spatial information of the position of the upper masticatory surface in the situation of the dura between C0 (skull base) and C2 (axis, 2nd cervical vertebra) - **mechanically**. When walking with the upper jaw surface oblique to the head, a new gyration, tilting and transversal shifting of body sections takes place in every phase of movement.

In this picture, the head tilts backwards so that the rear segments of the dura mater between C0 and C2 shorten (in the picture: (3) and (2)). The tension of these segments is reduced. The anterior part (1) is not affected. Hypothetically, there are 16 longitudinal segments through which the posture is autonomously adjusted. Each belongs to a maxillary tooth and controls a longitudinal body segment.

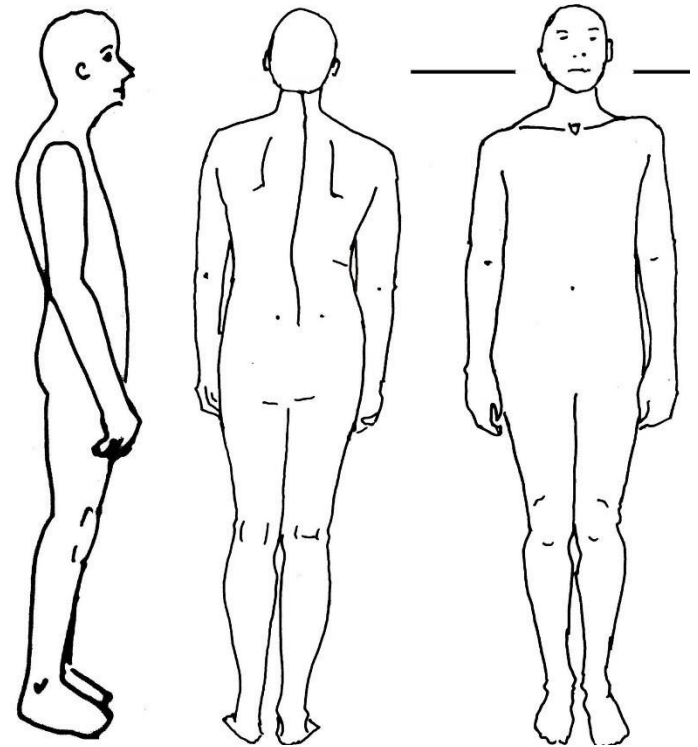
The length of the entire body segment is controlled by the tension/length/twist of the 16 longitudinal segments of the dura in the area C0-C2. This regulates the activity of the deep muscles: a shortening of a dura segment causes a shortening of the entire body wall.

Image: Shortening of the dorsal segments of the dura mater (red) in the area C0-C2 due to "head in neck". The shortening in the small section between C0-C2 leads to a shortening of the entire segments. Because the activity of the deep back muscles is reduced as a result, the whole back shortens (hollow round back).



Conception of a stimulus-response principle. How do the longitudinal segments of the dura mater affect muscles and posture?

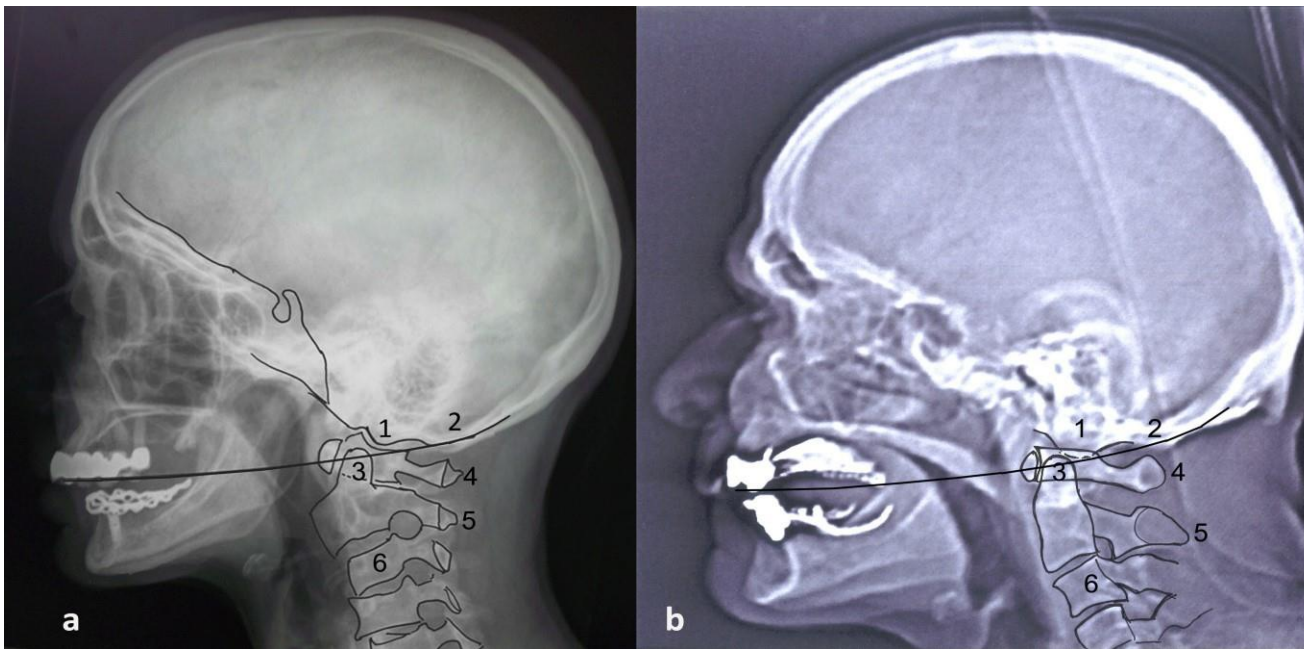
Lengthening a dural segment between C0-C2 increases the activity of the deep muscles (= stronger contraction). Contraction of the transversospinal musculature causes lengthening of the ipsilateral side of the body, i.e. precisely this body segment. When the dura segment between C0 and C2 is shortened, the entire body segment shortens due to a reduction in the activity of the deep musculature: In the example case, when the dura slackens and shortens, the activity of the right or posterior side of the torso decreases. The right and posterior torso longitudinal segments shorten and the adjacent posture occurs.



Segmental shortening in the right and posterior body segment

Conception of a stimulus-response principle. The skull base and the maxillary chewing surface form a common plane (2)

Sample 1: maxillary chewing surface rising at the back relative to the skull (line drawn). Teeth too flat at the back - head posture overextended. This structural alteration with a change in the shape of the skull happens quickly (weeks).

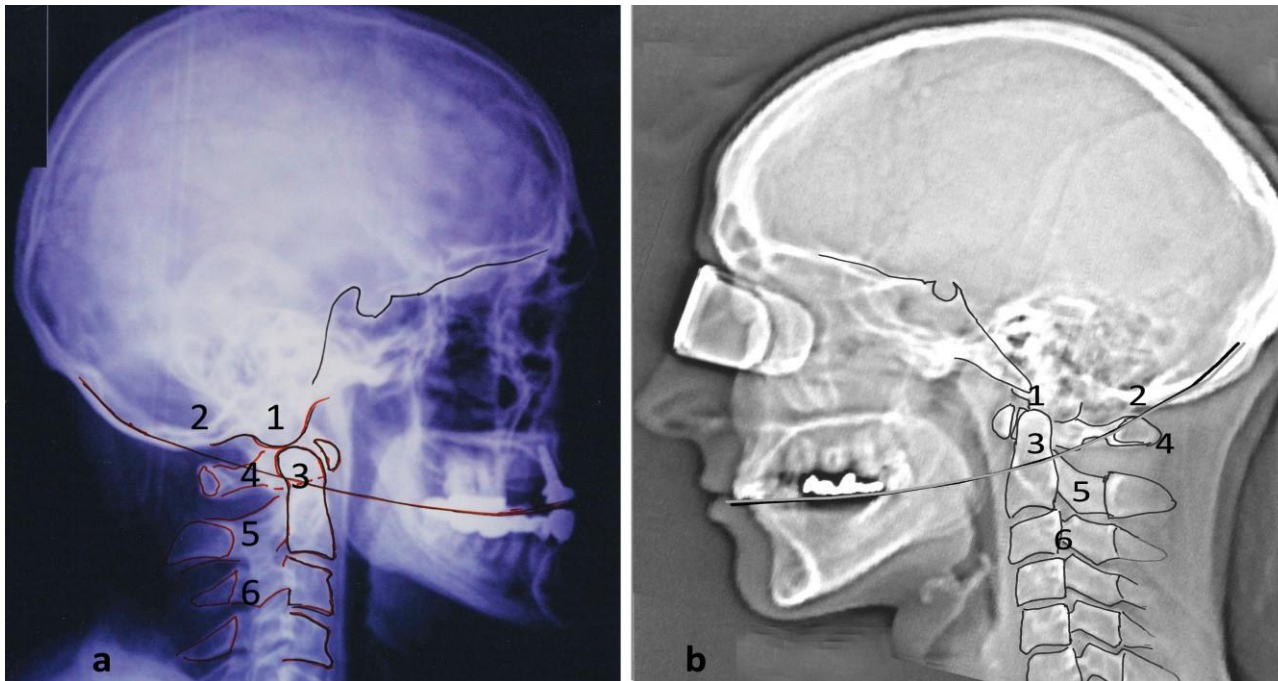


© Ruth Nebel

Atlas (4) and Axis (3,5) shift forward. The front end rotates upwards, the back end, the spinous processes 4,5) downwards. The "tooth of the axis" (dens axis) (3) tilts backwards. The spinous processes are close together. The pharynx is pulled apart. This is supported by the results of studies which, however, looked for a different triggering parameter (5,11-13).

Conception of a stimulus-response principle. The skull base and the maxillary chewing surface form a common plane (2)

Sample 2: maxillary chewing surface is lowered towards the skull at the back. The denture is too long at the top back, so the maxillary chewing surface slopes backwards. The back of the head is raised to bring it to the spatial position of the original maxillary chewing surface.

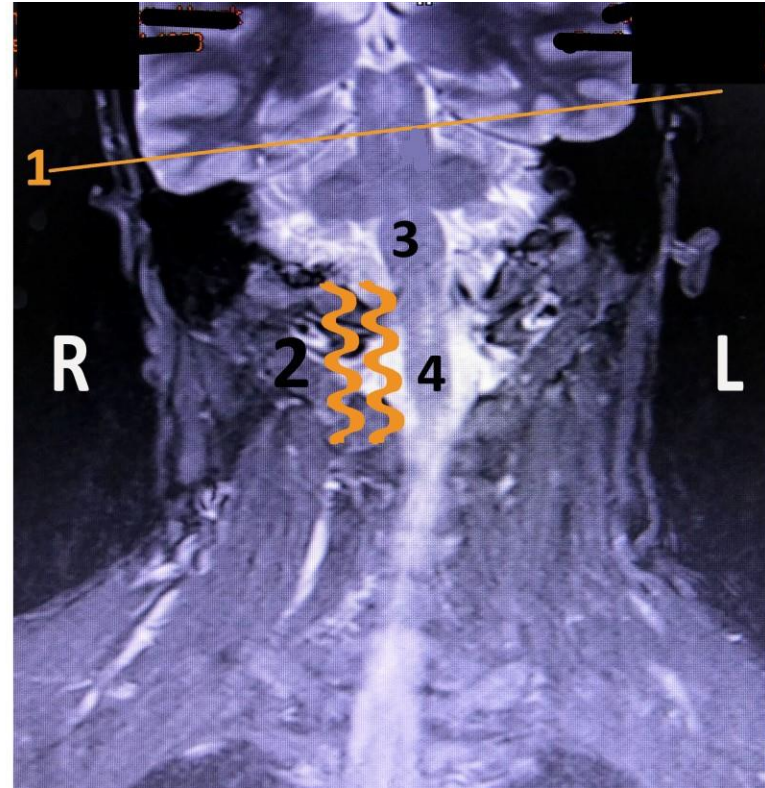
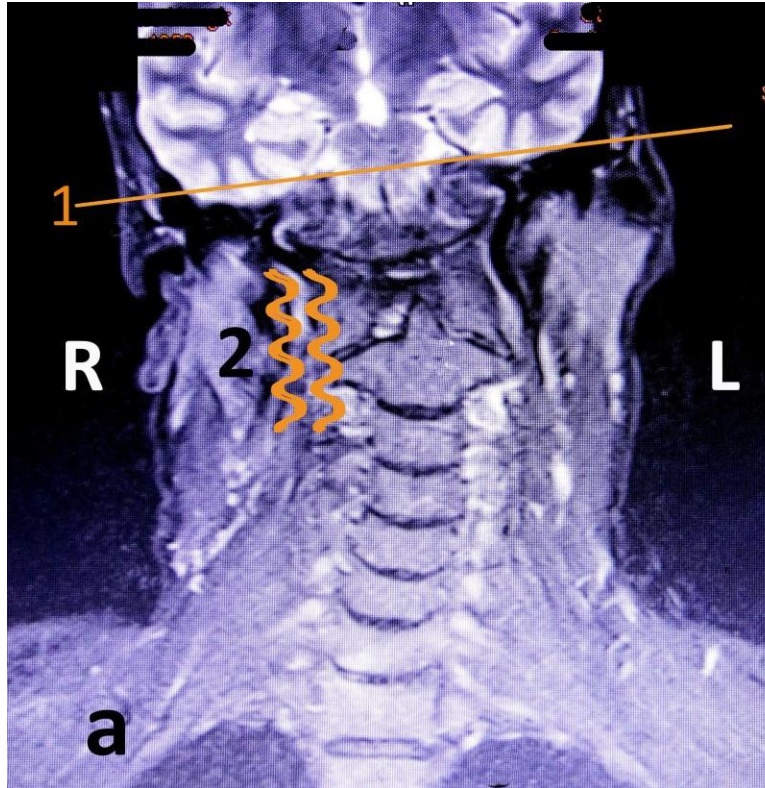


© Ruth Nebel

The dens axis (3) stands steeply here, the spaces between the spinous processes become larger (4,5,6). The atlas and axis are further back (4,3,5). The throat is narrow.

Impairment of the central nervous system

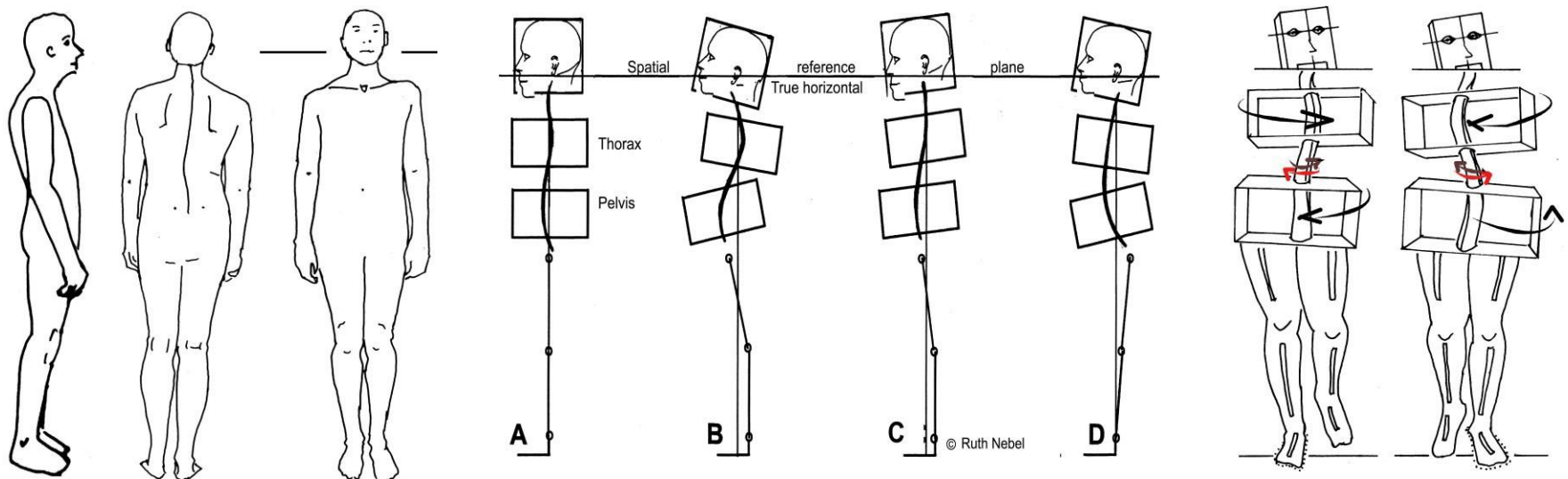
After several subsequent restorations, an oblique maxillary chewing surface may result. This example shows the view of the cervical spine after five subsequent restorations. Between the base of the skull and the axis, the spinal cord kinks and twists. This twisting also affects the brain (picture on the right).



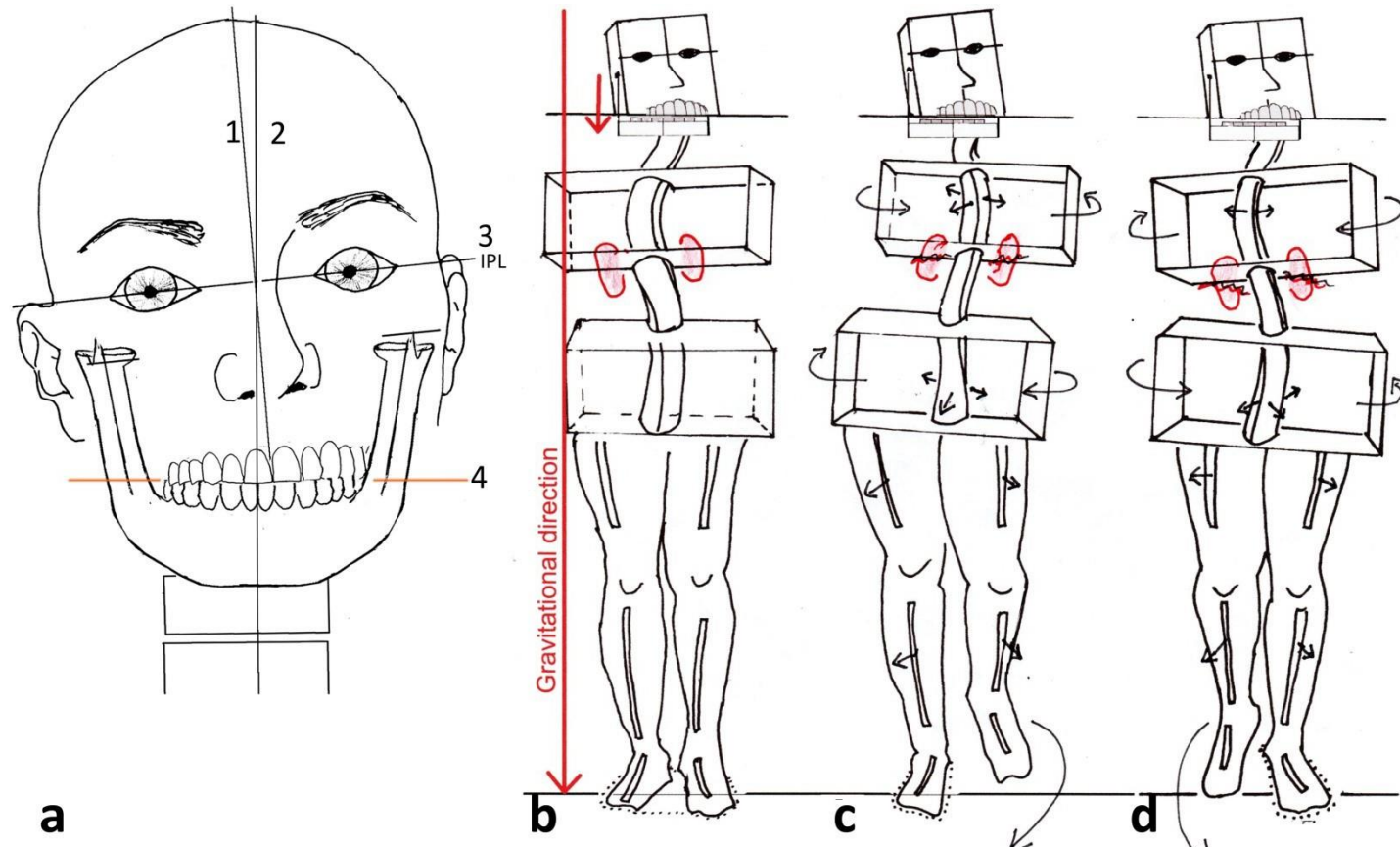
- 1) Transversal axis of the brain, which is oblique here due to altered head posture.
- 2) Dura, the covering of the spinal cord becomes slack due to permanent lateral inclination between the head and the cervical spine (HWS)
- 3) Brain area "bridge" and (4) myelon are angled on the cervical spine and are twisted with every movement.

Consequences of a maxillary chewing surface: Pain of undetected origine

These postures are called poor posture, "scoliosis" or hollow hunchback. Sometimes they are accompanied by spinal stenosis or spondylolisthesis. In fact, they are a temporary adjustment and a type of balancing reaction, whereby a maxillary chewing surface that is oblique to the head is aligned in a spatially constant way. It is called "CMD" by the dentist.

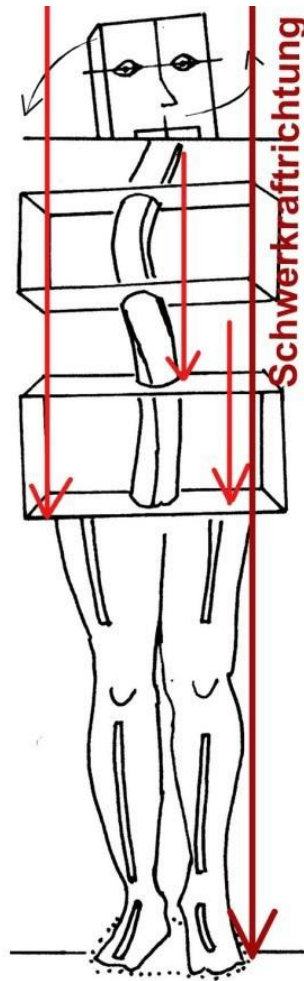


Pain: twisting occurs constantly when walking
the spine like wringing out a rag

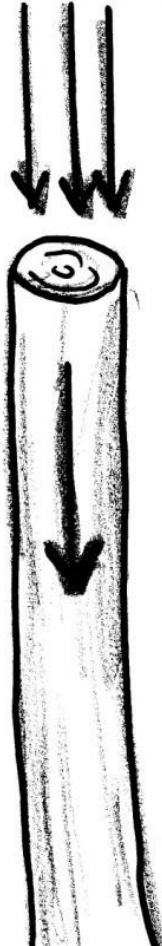


a) The dural longitudinal segments, which are shortened or twisted between C0-C2, mediate a shortening and slackening of the postural musculature in the body segments they supply. This results in law-like patterns. Oblique maxillary chewing surface results in oblique head posture, oblique eye and vestibular axis to synchronise a maxillary chewing surface that is oblique in the head stands. Gravity thus becomes shear force: b) stance, c) walking, stance leg phase right, d) left

Mechanic principle of pain: permanent incorrect loading through shearing forces. Gravity becomes a shearing force.



Belastung axial, „in Achse“
der belasteten Struktur,
auch in Achse ihrer Fasern



Belastung durch
Scherkraft, schräg
zur Achse und zum
Faserverlauf der
belasteten Struktur



Belastung durch
Torsionskräfte:
Durch Drehen
des Astes werden
seine Fasern
voneinander
getrennt.



The majority of back pain would thus be treatable

It is also possible that a large proportion of those considered "degenerative" or "age-related" disorders have their cause in an Inclination of the maxillary chewing surface .

Tooth length changes in the upper jaw affect almost all people. The physical impairments do not primarily depend on age, but on the number of subsequent restorations.

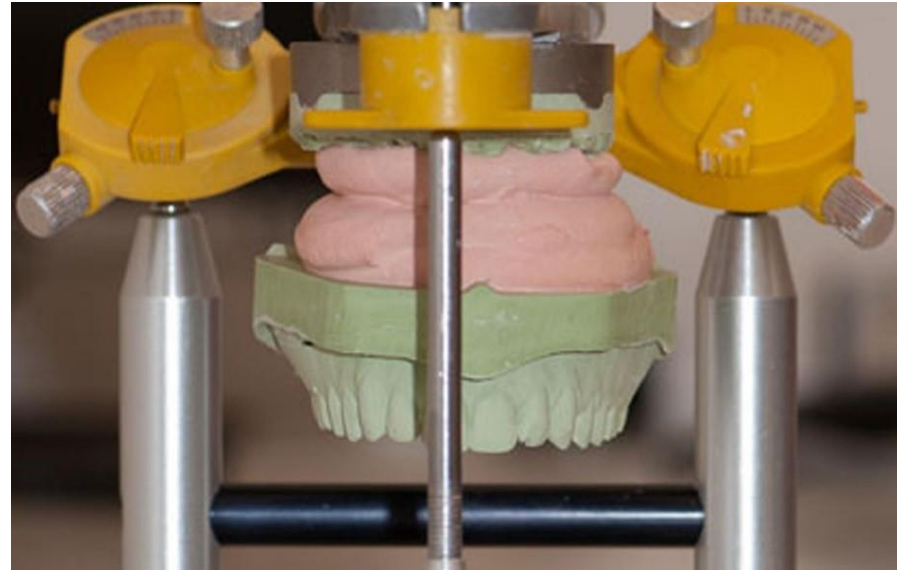
By restoring the position of the maxillary chewing surface, they are, like trial treatments have shown that even 80-year-olds can still be treated.

© Ruth Nebel

What is the source of error at the dentist? - conventional diagnostics



Dentures are made according to the bite block. The bite block is taken in the dentist's chair in a 30° backward position. The denture made, i.e. fillings, bridges, dentures, represents the jaw relation of 30° backward with its toothings. It does not represent the bite with an upright posture.

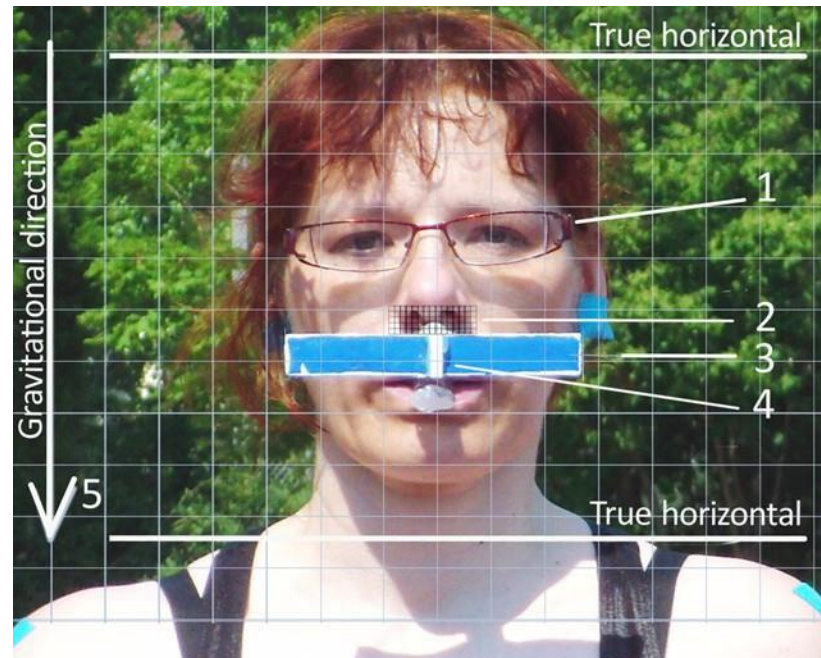
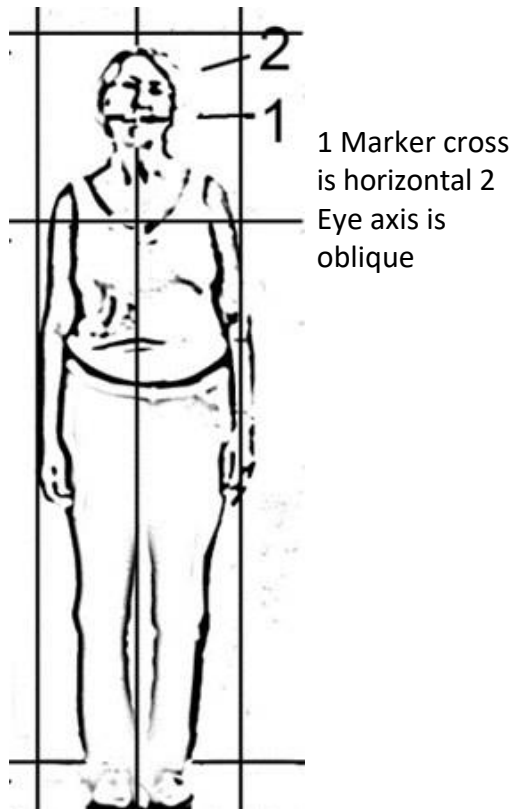


Plaster model of the maxillary prosthesis from the left picture. Its position in the articulator is arbitrary, because there is no reference of the head axes (such as eye or ear axis) in the conventional articulator. The position of the plaster model in the articulator shown here gives the impression that the upper jaw is almost in place.

"straight" in the skull. In this case, this is a Source of error for the next denture.

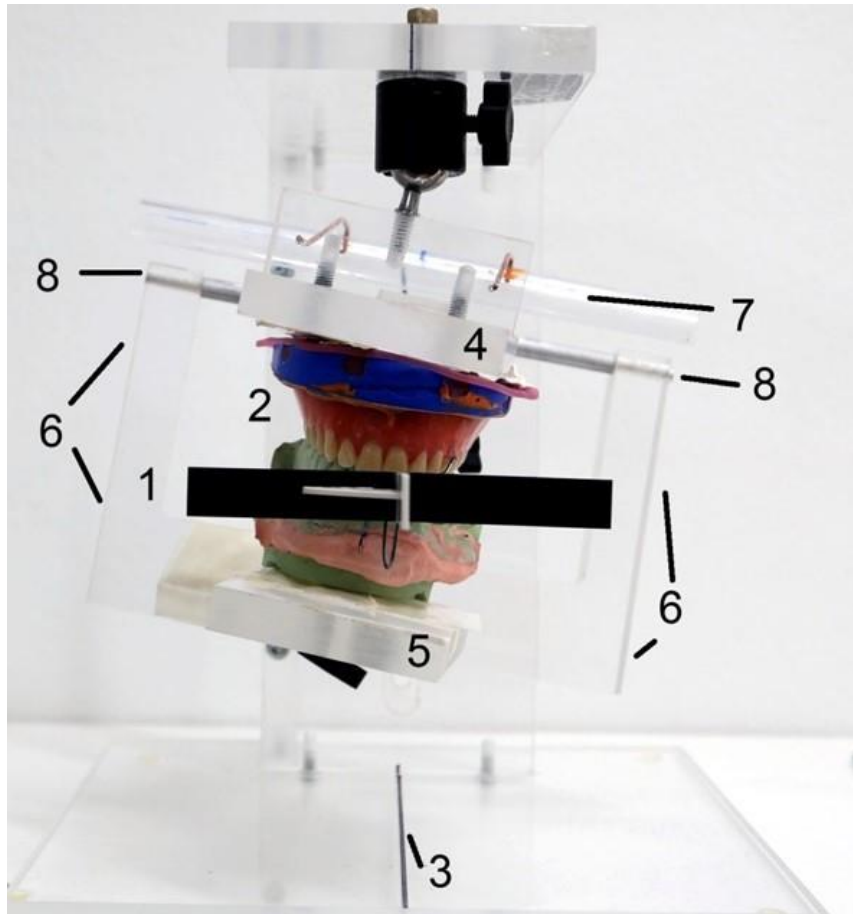
Involving the position of the maxillary chewing surface relative to environmental space - Step 1: Aligning the marker cross in vivo

On the patient, the marker cross is turned on its wire so that it is horizontal with one wing pointing forward during automatic locomotion. This is the manual approach. More accurate is a Vicon 3-D assisted positioning.



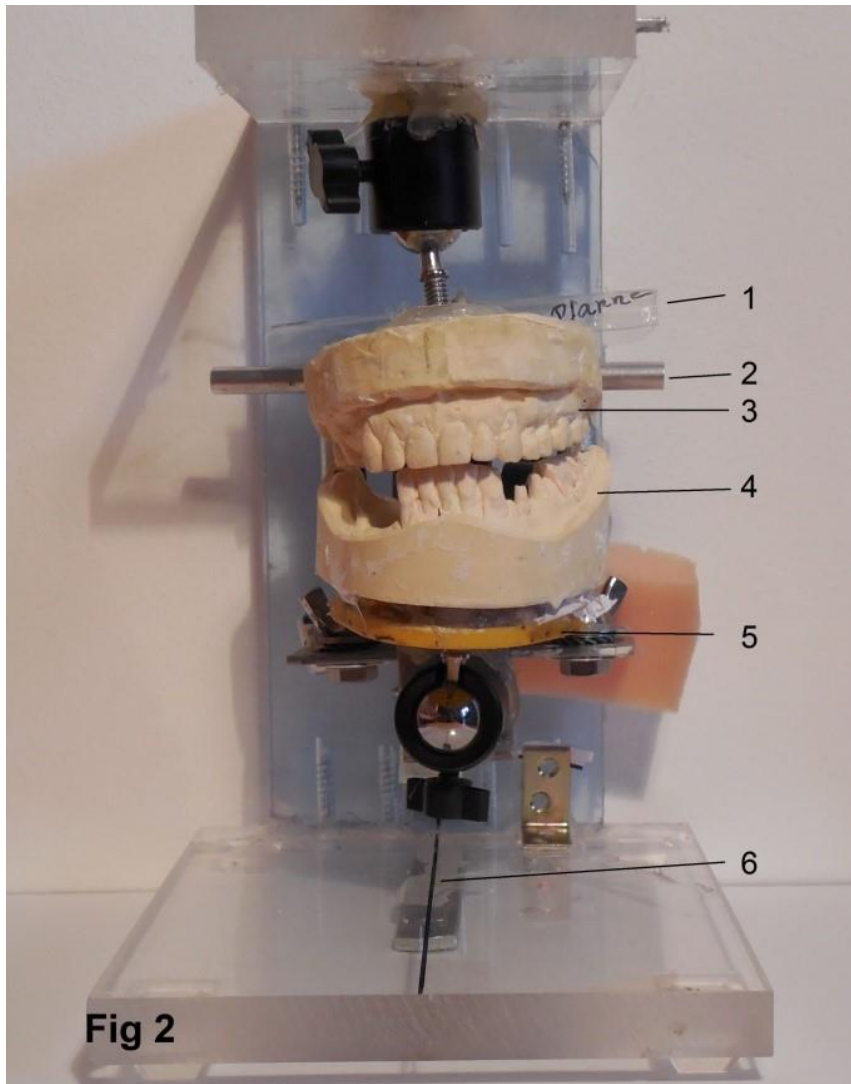
Involving the position of the maxillary chewing surface relative to environmental space - Step 2: Spatial articulator

For this purpose, a Spatial articulator® is used, which represents the environmental space and the direction of walking with its axes. The upper jaw model is inserted over the marker cross by aligning its wings along the axes of the articulator. This gives the position of the maxillary teeth (2) in the upright position. The head position can be read from the ear axis (7). When the head is tilted, there is a discrepancy with the axis of the mandibular heads (8).



1. Markerkreuz „echt“ horizontal;
2. Oberkieferprothese in realer Raumlage; übertragen via Markerkreuz
3. subjektives „Vorne“, Geh-/Blickrichtung
4. Oberkieferhalterung
5. Unterkiefersockel
6. Ramus
7. Fossa-Achse (an Oberkiefer)
8. Kieferköpfchenachse (an Unterkiefer)

An articulator should show the position to the space dimensions involve



Spatial plane articulator:

- 1 Maxillary cup axis,
- 2 Maxillary axis,
- 3 Upper jaw model, positioned by means of Marker cross
- 4 Mandibular model side inclined and right-rotated,
- 5 Lower jaw holder,
- 6 Base plate according to the Space horizontals, with sagittal line (walking direction) laterally inclined and rotated to the right, positioned by means of a marker cross

Fig 2

CMD treatment (craniomandibular dysfunction) - back pain, joint complaints, dizziness: making the fox the gardener

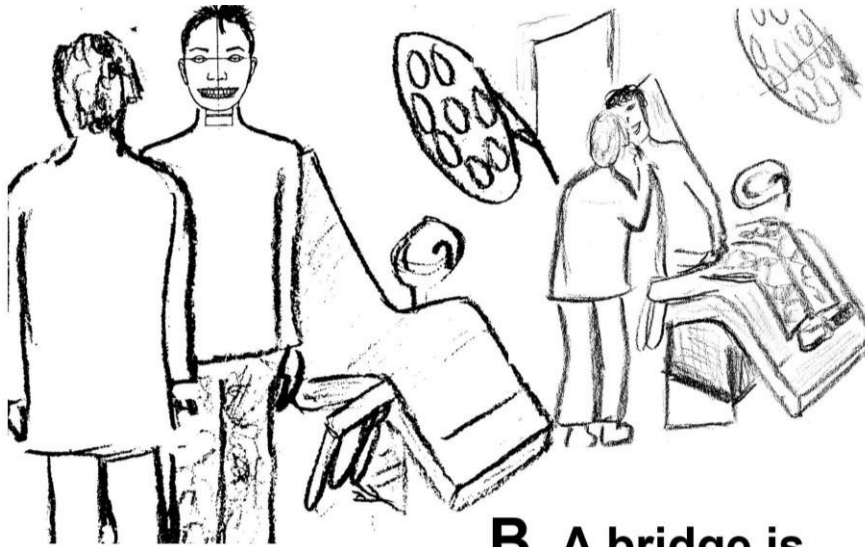
It is possible that 80% of back pain is related to a

The upper jaw masticatory plane is oblique.

It is also hypothetically involved in

- in almost all CMD patients (prevalence of CMD: 45-65%. It increases not diminishing despite intensified treatment services (Peroz, 2016)).
- for complaints of peripheral joints such as shoulder, hip, knee
- Headache
- for dizziness

Dentist comic: Inserting a bridge that is too flat



A Welcome The

A. Good day.
(Patient is
upright,
straight)



B. A bridge is

B. A bridge is inserted,
fresh from the dental
laboratory. It is flatter
on the right side of the
upper jaw than the
original teeth.



C. Goodbye. The

C. The patient's head and
body posture has changed
in 2 minutes. The head is
tilted to the right, the right
side of the torso slumps.

© Ruth Nebel

"Craniomandibular Dysfunction"

The previous assumptions and principles of dental treatments and "craniomandibular dysfunction" would have to be reconsidered: there is a disturbance between the "cranium" (head) and the mandible ("craniomandibular" dysfunction) is assumed. Consequently, the "occlusion", the Bite together or interlocking changed.

According to the model presented here, however, the problem may primarily lie in an oblique position of the maxillary occlusal surface in relation to the skull, which is subordinate to the clenching of the bite.

This assumption is supported by the symptoms that occur with "craniomandibular dysfunction": Dizziness, angle squint, balance disorders, the screwed posture (see above), which changes within 3 minutes when the upper jaw masticatory surface is corrected, are symptoms that fit the balance system / postural system rather than the masticatory system.

The therapy should therefore first restore the optimal position of the maxillary occlusal surface.

Further, dentistry suspects that there is a stimulus-response connection between the masticatory system and the musculoskeletal system. However, a reaction between different systems is unlikely. More likely is a stimulus-response connection in one and the same system. I suspect the complete reaction in the postural or orientation system. The position of the maxillary occlusal surface is a postural parameter, as is posture.

Occlusion - fatal misjudgement?

- It has been obvious for over 100 years that teeth influence posture. However, it is not known WHAT exactly is the connection, what is stimulus and what is reaction. Until now, only the "masticatory system" was taken into account. The "interlocking" (occlusion), the interlocking of the upper and lower teeth, was considered. The assumption is that a gapless occlusion causes good posture, whereas a gapless occlusion causes poor posture and pain. However, this connection could not be proven in many thousands of studies. In 2016, Michelotti published a review with the result that there is no connection between occlusion and posture.
- Tooth loss, fillings, sealants, bridges, dentures and orthodontics lead to length changes in 85% of dental treatment. These length changes can be seen by an oblique course of the upper jaw chewing plane, which is then at an angle to the eye axis. They can be observed in almost all people over 30 years of age.



Studies with questionable interpretations: does the change in occlusion actually lead to postural changes, or is the postural change caused by the displacement of the maxillary occlusal surface?

A connection between occlusion and posture and CMD has been suspected for over 30 years.

This could not be proven. Review studies did not establish a link (Michelotti , Manzo P, Farella M, Information, and - 1Istituto di Discipline Odontostomatologiche, Università degli Studi Federico II 1999); (Michelotti A1, Buonocore G, Manzo P, Pellegrino G 2011).

Intervention studies with splint <2 mm produced negative results (El Gourari, Ohlendorf, & Kopp, 2013; Marini et al., 2013)El Gourari, M., Ohlendorf, D., & Kopp, S. (2013). Effects of a bite block appliance on upper body statics in patients with craniomandibular complaints. *Manual Medicine*, 51(6), 484-492. doi:10.1007/s00337-013-1070-4; Marini, I., Gatto, M. R., Bartolucci, M. L., Bortolotti, F., Alessandri Bonetti, G., & Michelotti, a. (2013). Effects of experimental occlusal interference on body posture: an optoelectronic stereophotogrammetric analysis. *Journal of Oral Rehabilitation*, 40(7), 509-18. doi:10.1111/joor.12064

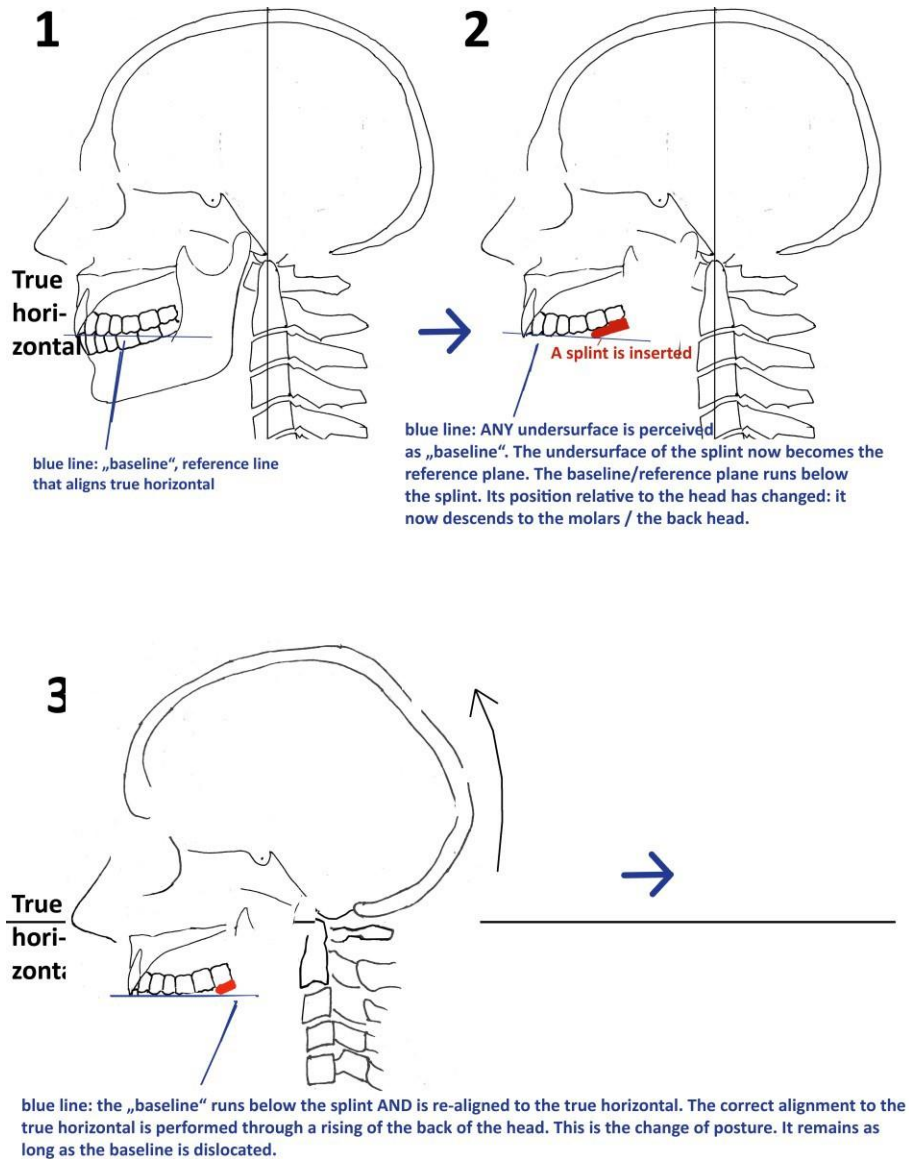
Only studies with thick splints >4 mm produced postural changes.(Moon and Lee 2011)(Kopp et al. 2003)(Ohlendorf et al. 2014a)(Strini et al. 2009)

Conclusion: Because splints etc. also change the height, the postural changes appear to be an effect of the change in height, i.e. the position of the masticatory plane. The interpretation of the triggering stimulus as "occlusal change" would therefore be wrong.

Regarding "occlusion changes posture": Studies in which the chewing plane was also shifted unnoticed by the change in occlusion. Their results indicate a balance reaction (both unnoticed).

- D'Attilio, M., Filippi, M. R., Femminella, B., Festa, F., & Tecco, S. (2005). The influence of an experimentally-induced malocclusion on vertebral alignment in rats: a controlled pilot study. *Cranio : The Journal of Craniomandibular Practice*, 23(2), 119-29. doi:10.1179/crn.2005.017.
- Funakoshi, M., Fujita, N., & Takehana, S. (1976). Relations Between Occlusal Interference and Jaw Muscle Activities in Response to Changes in Head Position. *Journal of Dental Research*, 55(4), 684-690. doi:10.1177/00220345760550042401.
- Huggare, J. A., & Raustia, A. M. (1992). Head posture and cervicovertebral and craniofacial morphology in patients with craniomandibular dysfunction. *Cranio : The Journal of Craniomandibular Practice*, 10(3), 173-7; discussion 178-9. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/1423679>
- Makofsky, H. W., Sexton, T. R., Diamond, D. Z., & Sexton, M. T. (1991). The effect of head posture on muscle contact position using the T-Scan system of occlusal analysis. *Cranio : The Journal of Craniomandibular Practice*, 9, 316-321. doi:PMID: 1820831
- Manuscript, A., & Sensory, N. P. (2013). Signals in the Cerebellar Interpositus, 33(3). doi:10.1523/JNEUROSCI.3460-12.2013.Convergence.
- Salonen, M. A., Raustia, A. M., & Huggare, J. (1993). Head and cervical spine postures in complete denture wearers. *Cranio : The Journal of Craniomandibular Practice*, 11(1), 30-3; discussion 34-5. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/8358805>
- Schupp, W., & Säckler, I. (2005). Verification of occlusion in craniomandibular dysfunction with manual medicine diagnostics and the Formetric measurement. *Manual Medicine*, 43(5), 331-341. doi:10.1007/s00337-005-0381-5.
- Sonnesen, L., Bakke, M., & Solow, B. (2001). Temporomandibular disorders in relation to craniofacial dimensions, head posture and bite force in children selected for orthodontic treatment. *European Journal of Orthodontics*, 23(2), 179-92. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/11398555>

What the studies on the connection between occlusion and posture was overlooked (I):



Re "posture changes occlusion". Studies that applied unilateral shoe elevation and overlooked and misinterpreted the balance reaction

1. Gangloff P, Louis JP, Perrin PP. Dental occlusion modifies gaze and posture stabilization in human subjects. *Neurosci Lett* [Internet]. 2000 Nov 3 [cited 2015 May 14];293(3):203-6. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/11036196>
2. Gillies GT, Christy DW, Stenger JM, Broaddus WC. Equilibrium and non-equilibrium dynamics of the cranio-mandibular complex and cervical spine. *J Med Eng Technol* [Internet]. 2003 Jan [cited 2014 Jul 2];27(1):32-40. Available from: <http://informahealthcare.com/doi/abs/10.1080/03091900210167542>
3. Huang P, Zhang D. [Condylar position and condylar symmetry in patients with temporomandibular disorders]. *Shanghai Kou Qiang Yi Xue* [Internet]. 2012 Dec [cited 2015 Jan 16];21(6):663-7. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/23364552>
4. Ohlendorf D, Pusch K, Kopp S. Leg length difference versus centric position of the mandible. *Man Medicine* [Internet]. 2008 Dec 6 [cited 2014 Aug 1];46(6):418-23. Available from: <http://link.springer.com/10.1007/s00337-008-0655-9>
5. Sakaguchi K, Mehta NR, Abdallah EF, Forgione AG, Hirayama H, Kawasaki T YA. Examination of the relationship between mandibular position and body posture. Boston, MA 02111, USA: *Cranio : the journal of craniomandibular practice*; 2007. p. 237-49.
6. Sakaguchi K, Mehta NR, Abdallah EF, Forgione AG, Hirayama H, Kawasaki T, et al. Examination of the relationship between mandibular position and body posture. *Cranio* [Internet]. 2007 Oct [cited 2014 Jul 13];25(4):237-49. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/17983123>
7. Zhang X, Zhou C, Bai Y, Yang X, Wang B. [Relationship between condyle movement and disc position in patients with Class II division 1 malocclusion]. *Zhonghua Kou Qiang Yi Xue Za Zhi* [Internet]. 2010 Jan [cited 2015 Jan 16];45(1):16-9. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/20368034>
8. Araki NG, Araki CT. Head angulation and variations in the maxillomandibular relationship. Part II: The effects on facial contour and lip support. *J Prosthet Dent* [Internet]. 1987 Aug [cited 2014 Jul 13];58(2):218-21. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/3476730>
9. Chapman RJ, Maness WL, Osorio J. Occlusal contact variation with changes in head position. *Int J Prosthodont* [Internet]. Jan [cited 2014 Jul 13];4(4):377-81. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/181163310>. Hosoda M, Masuda T, Isozaki K, Takayanagi K, Sakata K, Takakuda K, et al. Effect of occlusion status on the time required for initiation of recovery in response to external disturbances in the standing position. *Clin Biomech (Bristol, Avon)* [Internet]. 2007 Mar [cited 2017 May 12];22(3):369-73. Available from: <http://linkinghub.elsevier.com/retrieve/pii/S0268003306002154>
11. Maeda N, Sakaguchi K, Mehta NR, Abdallah EF, Forgione AG, Yokoyama A. Effects of experimental leg length discrepancies on body posture and dental occlusion. *Cranio* [Internet]. 2011 Jul [cited 2017 May 12];29(3):194-203. Available from: <http://www.tandfonline.com/doi/full/10.1179/crn.2011.028>
12. Makofsky HW, Sexton TR, Diamond DZ, Sexton MT. The effect of head posture on muscle contact position using the T-Scan system of occlusal analysis. *Cranio*. New York: *Cranio*; 1991;9:316-21.
13. Miles TS. Postural control of the human mandible. *Arch Oral Biol* [Internet]. 2007 Apr [cited 2015 Jun 7];52(4):347-52. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/17257577>
14. Obert M, Ohlendorf D, Kopp S. Occlusion disorders and effects on the functional range of motion of the lumbar spine. *Man Medicine*. 2012;50(50):124-31.

Continuation: Studies whose results indicate balance reactions but which were not recognised

15. Padala S, Padmanabhan S, Chithranjan AB. Comparative evaluation of condylar position in symptomatic (TMJ dysfunction) and asymptomatic individuals. *Indian J Dent Res* [Internet]. Jan [cited 2015 Jan 16];23(1):122. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/22842268>
 16. Persch M, Hans C, Getto R. Normal movement patterns of the upper extremity. *Prax Occupational Therapy*. 2008;21(21):298-301.
 17. Schupp W, Oraki A, Haubrich J, Freesmeyer WB, Kopsahilis N. Occlusal changes and their effects on the postural and supporting apparatus. Investigation by manual medical test procedures. *Man Medicine*. 2009;47(April):107–11.
 18. Sener S, Akgunlu F. Correlation between the Condyle Position and Intra-Extraarticular Clinical Findings of Temporomandibular Dysfunction. *Eur J Dent* [Internet]. 2011 Jul [cited 2015 Jan 16];5(3):354-60. Available from: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3137453&tool=pmcentrez&rendertype=abstract>
 19. Urbanowicz M. Alteration of vertical dimension and its effect on head and neck posture. *Cranio*. 1991;9:174-9.
 20. van't Spijker A, Creugers NHJ, Bronkhorst EM, Kreulen CM. Body position and occlusal contacts in lateral excursions: a pilot study. *Int J Prosthodont* [Internet]. Jan [cited 2016 Feb 25];24(2):133-6. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/21479279>
 21. Wakano S, Takeda T, Nakajima K, Kurokawa K, Ishigami K. Effect of experimental horizontal mandibular deviation on dynamic balance. *J Prosthodont Res* [Internet]. 2011 Oct [cited 2016 Feb 25];55(4):228-33. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/21550328>
 22. Yoshida M, Kanehisa Y, Ozaki Y, Iwasa Y, Fukuizumi T, Kikutani T. One-leg standing time with eyes open: comparison between the mouth-opened and mouth-closed conditions. *Cranio* [Internet]. 2015 Jan [cited 2015 Jun 16];33(1):15-8. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/25547139>
- Hosoda, M., Masuda, T., Isozaki, K., Takayanagi, K., Sakata, K., Takakuda, K., ... Morita, S. (2007). Effect of occlusion status on the time required for initiation of recovery in response to external disturbances in the standing position. *Clinical Biomechanics (Bristol, Avon)*, 22(3), 369-73. doi:10.1016/j.clinbiomech.2006.11.001
- Sakaguchi K, Mehta NR, Abdallah EF, Forgione AG, Hirayama H, Kawasaki T, Y. A. (2007). Examination of the relationship between mandibular position and body posture. Boston, MA 02111, USA: *Cranio : the journal of craniomandibular practice*. doi:CN-00620706
- Wakano, S., Takeda, T., Nakajima, K., Kurokawa, K., & Ishigami, K. (2011). Effect of experimental horizontal mandibular deviation on dynamic balance. *Journal of Prosthodontic Research*, 55(4), 228-33. doi:10.1016/j.jpor.2011.03.001.
- Yoshida, M., Kanehisa, Y., Ozaki, Y., Iwasa, Y., Fukuizumi, T., & Kikutani, T. (2015). One-leg standing time with eyes open: comparison between the mouth-opened and mouth-closed conditions. *Cranio : The Journal of Craniomandibular Practice*, 33(1), 15-8. doi:10.1179/2151090314Y.0000000007

On "Position of the mandible influences balance and Extent of movement" (=impairment of tooth contact afferents of the mandible limited balance)

1. Decisive for balance was the limitation of the mobility of the mandible or the interfering tooth contact (Sakaguchi K, Mehta NR, Abdallah EF, Forgione AG, Hirayama H, Kawasaki T 2007) (Pierre Gangloff et al. 2000). Note concerning the quotes: the present paper refers to the results in the quoted studies, although the interpretation might be discrepant.
2. Eliminating tooth contact worsens balance (Yoshida et al. 2015) (Hosoda M, Masuda T, Isozaki K, Takayanagi K, Sakata K, Takakuda K, Nitta O 2007) therefore leads to an unstable balance (Yoshida et al. 2015).
3. The fixing of the mandible effects body posture (Pierre Gangloff et al. 2000) (Urbanowicz 1991)(Sakaguchi K, Mehta NR, Abdallah EF, Forgione AG, Hirayama H, Kawasaki T 2007): The results stated an influence on balance (body sway) and on the extent of movement. (Miles 2007)(Gillies et al. 2003).

The position of the mandible has been found to be related to TMD (Zhang et al. 2010).

Literature, studies on: Dental asymmetry causes problems

Patients with TMD show significant deviations at the level of occlusion as well as greater condylar displacements than asymptomatic people (Padala, Padmanabhan, and Chithranjan). Complete denture wearers often show TMD symptoms (Papagianni et al. 2013) (2).

Its position influences the position of the condyles, the joint-space and the discus articularis in the TMJ (Sener and Akgunlu 2011)(Chapman et al.)(Padala et al.).Changes in the muscle courses effect the basic activity of muscles (Sener and Akgunlu 2011) and the function.

In edentulous patients, the angulations have been found to be changed with symptoms of TMD(Araki and Araki 1987).There have been found asymmetries in the condyle position in TMD-patients (Padala et al.)(Huang and Zhang 2012).

the tongue position has been found correspondent to certain knee postures(di Vico et al. 2013) (24).

Literature, studies with further references to the postural Function of teeth and jaws

- Ali, A. S., Rowen, K. A., & Iles, J. F. (2003). Vestibular actions on back and lower limb muscles during postural tasks in man, 615-624. doi:10.1113/jphysiol.2002.030031.
- Allum, J., Bloem, B., Carpenter, M., Hulliger, M., & Hadders-Algra, M. (1998). Proprioceptive control of posture: a review of new concepts. *Gait & Posture*, 8(3), 214-242. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/10200410>
- Aoki, M., Matsunami, K., y Han, X., Yamada, H., Muto, T., & Ito, Y. (2001). Neck muscle responses to abrupt vertical acceleration in the seated human. *Experimental Brain Research*, 140(1), 20-4. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/11500794>
- Bergmark, A. (1989). Stability of the lumbar spine. A study in mechanical engineering. *Acta Orthopaedica Scandinavica. Supplementum*, 230, 1-54. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/2658468>
- Bonney, R. A., & Corlett, E. N. (2002). Head posture and loading of the cervical spine. *Applied Ergonomics*, 33(5), 415-7. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/12236650>
- Gangloff, P., Louis, J. P., & Perrin, P. P. (2000). Dental occlusion modifies gaze and posture stabilization in human subjects. *Neuroscience Letters*, 293(3), 203-6. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/11036196>
- Hiebert, A., Jonckheere, E., Lohsoonthorn, P., Mahajan, V., Musuvathy, S., & Stefanovic, M. (2006). Visualization of a stationary CPG-revealing spinal wave. *Studies in Health Technology and Informatics*, 119, 198-200. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/16404044>
- Hoffer, M., Gottshall, K., Weisskopf, P., Moore, R., & Kopke, R. (n.d.). *The Role of "Extra-Vestibular" Inputs in Maintaining Spatial. RTO-MP-086*. La coruba, Spain. <http://de.inforapid.org>. (n.d.).
- <http://www.spektrum.de/lexikon/neurowissenschaft/mechanorezeptoren/7484>. (2000). *Lexicon of Neuroscience Spektrum Akademischer Verlag*.
- Huntley, A. H., & Zettel, J. L. (2015). Effects of temporal and spatial cueing on anticipatory postural control in a rapid interceptive task. *Neuroscience Letters*, 592, 82-7. doi:10.1016/j.neulet.2015.02.054
- Inglis, J. T., Horak, F. B., Shupert, C. L., & Jones-Rycewicz, C. (1994). The importance of somatosensory information in triggering and scaling automatic postural responses in humans. *Experimental Brain Research*, 101(1), 159-64. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/7843295>
- Ivanenko, Y. P., Grasso, R., & Lacquaniti, F. (1999). Effect of gaze on postural responses to neck proprioceptive and vestibular stimulation in humans. *The Journal of Physiology*, 519 Pt 1, 301-14. Retrieved from <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2269485&tool=pmcentrez&rendertype=abstract>
- Ivanenko, Y. P., Grasso, R., & Lacquaniti, F. (2000). Influence of leg muscle vibration on human walking. *Journal of Neurophysiology*, 84(4), 1737-47. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/11024066>
- Maeda, N., Sakaguchi, K., Mehta, N. R., Abdallah, E. F., Forgione, A. G., & Yokoyama, A. (2011). Effects of experimental leg length discrepancies on body posture and dental occlusion. *Cranio : The Journal of Craniomandibular Practice*, 29(3), 194-203. doi:10.1179/crn.2011.028
- Meier, M. L., Hotz-Boendermaker, S., Boendermaker, B., Luechinger, R., & Humphreys, B. K. (2014). Neural responses of posterior to anterior movement on lumbar vertebrae: a functional magnetic resonance imaging study. *Journal of Manipulative and Physiological Therapeutics*, 37(1), 32-41. doi:10.1016/j.jmpt.2013.09.004.
- Mitchell, B. S., Humphreys, B. K., & O'Sullivan, E. Attachments of the ligamentum nuchae to cervical posterior spinal dura and the lateral part of the occipital bone. *Journal of Manipulative and Physiological Therapeutics*, 21(3), 145-8. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/9567232>
- Morningstar, M. W., Pettibon, B. R., Schlappi, H., Schlappi, M., & Ireland, T. V. (2005). Reflex control of the spine and posture: a review of the literature from a chiropractic perspective. *Chiropractic & Osteopathy*, 13, 16. doi:10.1186/1746-1340-13-16.
- Munk. (2010). *Zoology* (Vol. 1, pp. 502-520; 6.4 Sensory organs and systems 6).
- Pontell, M. E., Scali, F., Enix, D. E., Battaglia, P. J., & Marshall, E. (2013). Histological examination of the human obliquus capitis inferior myodural bridge. *Annals of Anatomy = Anatomischer Anzeiger : Official Organ of the Anatomische Gesellschaft*, 195(6), 522-6. doi:10.1016/j.aanat.2013.04.013
- Reeves, N. P., Narendra, K. S., & Cholewicki, J. (2007). Spine stability: the six blind men and the elephant. *Clinical Biomechanics (Bristol, Avon)*, 22(3), 266-74. doi:10.1016/j.clinbiomech.2006.11.011.
- Weber, P., Corrêa, E. C. R., Ferreira, F. dos S., Soares, J. C., Bolzan, G. de P., & Silva, A. M. T. da. (2012). Cervical spine dysfunction signs and symptoms in individuals with temporomandibular disorder. *Jornal Da Sociedade Brasileira de Fonoaudiologia*, 24(2), 134-9. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/22832680>
- Yasuda, T., Nakagawa, T., Inoue, H., Iwamoto, M., & Inokuchi, A. (1999). The role of the labyrinth, proprioception and plantar mechanosensors in the maintenance of an upright posture. *European Archives of Oto-Rhino-Laryngology : Official Journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : Affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery*, 256 Suppl , S27-32. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/10337523>
- Yoshida, M., Kanehisa, Y., Ozaki, Y., Iwasa, Y., Fukuizumi, T., & Kikutani, T. (2015). One-leg standing time with eyes open: comparison between the mouth-opened and mouth-closed conditions. *Cranio : The Journal of Craniomandibular Practice*, 33(1), 15-8. doi:10.1179/2151090314Y.0000000007.
- Zazulak, B. T., Hewett, T. E., Reeves, N. P., Goldberg, B., & Cholewicki, J. (2007). Deficits in neuromuscular control of the trunk predict knee injury risk: a prospective biomechanical-epidemiologic study. *The American Journal of Sports Medicine*, 35(7), 1123-30. doi:10.1177/0363546507301585.

Studies on anatomical peculiarities of the Base of skull region

- Neuron fields in the dura
 - Dura connected to deep neck muscles, upper cervical joints, occiput and spinal canal.
1. Mitchell BS, Humphreys BK, O'Sullivan E. Attachments of the ligamentum nuchae to cervical posterior spinal dura and the lateral part of the occipital bone. J Manipulative Physiol Ther [Internet]. Jan [cited 2015 Jun 16];21(3):145-8. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/9567232>
 2. Pontell ME, Scali F, Enix DE, Battaglia PJ, Marshall E. Histological examination of the human obliquus capitis inferior myodural bridge. Ann Anat [Internet]. 2013 Dec [cited 2015 Jun 16];195(6):522-6. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/23867598>
 3. Yasuda T, Nakagawa T, Inoue H, Iwamoto M, Inokuchi A. The role of the labyrinth, proprioception and plantar mechanosensors in the maintenance of an upright posture. Eur Arch Otorhinolaryngol [Internet]. 1999 Jan [cited 2015 Jun 16];256 Suppl :S27-32. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/10337523>