Adopting good posture as a dentist
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Professor Oene Hokwerda asks whether a proprioceptive derived (pd) posture fits in with this.

"In 1962 Dr Daryl Beach presented the theory of *proprioceptive derived (pd) posture;* the idea that the dentist can use proprioceptive self-awareness to determine the most efficient, stress-free method to perform dental procedures. This is called the pd concept or performance logic directed at adopting a Balanced Home Position. This concept states it would be possible to attain an ideal and balanced posture, with the fingers in a position in the mid-sagittal (symmetrical) plane of the body, which is where one works with the highest precision and control with the least stress. This is called the finger control position or zero point. One assumes that human beings have the innate capability for reaching this, that this is reproducible within very fine tolerances with successive tasks and that posture and position of fingers is similar for all individuals. We looked for literature supporting this approach but found only contributions of pd dentists. [1-7]

"To check our knowledge about proprioception we discussed it with the Human Movement Sciences Department of the Faculty of Medical Sciences in Groningen (the Netherlands). As a usable background for this information we were advised to use Wikipedia and its included references.[8]

"The functioning of proprioception will now be described, followed by its conscious use and the consequences of the current knowledge regarding proprioception and then finally concluding remarks."

How proprioception functions regarding posture

"Posture is the result of a long process of growth and development, starting when learning to sit, crawl, stand and walk, ending when growth is finished. During this period, and for the rest of our lives, posture is influenced by hereditary, socio-economical and health factors.

"Proprioception is experiencing one's own body during standing, walking, sitting and moving. It is defined as the perception of the position of the body, or parts of it, in space and the load on muscles, tendons and joints. It prevents us from falling down and may lead to reducing the strain on our posture. Proprioception is primarily an information flow from muscles, tendons and joints to the central nervous system.[13-15] It is part of the reflexes situated in the motor cortex of the brain that are steering posture and movements automatically and unconsciously. However proprioception is only one of the faculties used by the body to arrange a balanced posture. Proprioception is linked to vestibular and visual information,[15-16] loss of one of these three faculties always leads to impairment of movement. Proprioceptive and vestibular stimuli have their own way of maintaining a balanced posture through use of the muscles, by stretching and balancing. The motor cortex always sends copies of the locomotive commands for the muscles to the cerebellum. Here, the fine-tuning of the movements occurs, based upon information from the muscles via the motor cortex, this is a feed-back chain. The horizon line in relation to internal equilibrium makes up an important check. In the course of our lives this visual system becomes more important as the conduction of proprioceptive and vestibular stimuli decreases.

"The balance that maintains the posture is different when we compare standing and sitting because during sitting the influence of the proprioception of the legs is diminished, while the possibilities for movement of the body are decreased. When standing the body is continuously moving, constantly fine tuning the balance by an alternating use of the muscles. When seated, the necessary balance information can only come from the hip joints, the sacro-iliacal joints, the mechanical pressure from the seating bone tubercles and their surrounding muscle groups, leading to substantial less information. The softer the material of the upholstery, the bigger the soft tissue (muscles and skin) area will be. This leads to even less balance information from the aforementioned tubercles

and joints and this leads to instability of the pelvic position, resulting in a hyperlordosis of the lumbar spine or in a slouching posture.

“Proprioception takes a given posture as starting point; it may be a normal posture, a habitual posture or a posture with musculoskeletal complaints. Even in the case of very bad posture, this can be taken as the individual standard for steering movements by proprioception. Usually one does not loose proprioception to the point of falling down, but in painful muscles proprioception is disturbed. Finally proprioception works so fast that these balancing movements are happening before one realises this. Recent research has shown that decisions in the brains are mostly already made before we are aware of them.”[19]

Conscious use of proprioception

“Proprioception mainly works automatically as part of reflex chains for keeping the body balanced and arranging movements. But it is possible to perceive the load on the muscles, tendons and joints consciously and to use this perception for adapting the posture and for guiding simple movements. The use of proprioception as a guide for movement can be experienced by closing the eyes and touching the nose with the index finger. Proprioception is not a pre-programmed ideal situation, so it cannot be expected that the body, through proprioception with visual and vestibular stimuli, would automatically steer towards an ideal or normal posture and a correct finger control position. This would require learning complex patterns for arranging posture and the movements of the hands. A learning process is necessary for acquiring a proper posture, starting with determining objectives for a physiologically acceptable posture, understanding how to reach it and then executing the necessary actions, followed by feedback via a coach, mirror, video camera (webcam) or myo-feedback. Horizontal and vertical references from the surroundings have to be used for checking one’s own posture. Feedback is essential because self-awareness has proved to be insufficient to determine how to adopt a proper posture. So guidance is needed for learning to feel the proprioceptive information from muscles, tendons and joints and its meaning for posture and movements.

“The learning process for optimally using proprioception proceeds from the cognitive (knowing what and how to do it and executing it) to the associative (combining different procedures) and ends (hopefully) in an automatically running process. In this way mental pictures about arranging posture and instrument handling are built up and new patterns are developed in the neural network for posture and movements. The possibility of this process has been shown, but there are big variations in individual learning abilities. When musculoskeletal complaints do exist, a therapist is needed to obtain knowledge and insight in posture and movements to first achieve optimal functioning of the ‘disabled’ body; at which point ergonomic principles must get full attention.

“For training to use a pd approach, dentists originally had to follow a SATV (Skill Acquisition, Transfer and Verification) program of six stages with feedback.”

Consequences of current knowledge regarding prioprioception

“Studies by Chaikumarn found that even pd dentists show deviating postures.[9,10] During the last meeting of ESDE, in 2008, it was shown that for a subject with poor posture, with muscles that were sore when palpated and later for the same subject with a corrected posture, that a pd posture and working height could be arranged. Also, different subjects showed different working heights. This should not be possible if the theory is right. The description as given above of the functioning of proprioception clarifies that proprioception does not automatically bring about the wanted natural and balanced posture and finger control position. The example given above shows that proprioception is adapting to each given posture.

“The reference posture used for the pd posture is physiologically wrong (too low, not a lordosis position of the back, no support of the back or pelvis and a high strain on the muscles to keep the body upright). Furthermore, one may question whether the reference activities used to determine the height of the working field - *e.g.*, putting a thread through the eye of a needle - were the right reference activities. There have been no studies to check this and no information is available in medical or dental literature discussing the pd posture, except from adherents of the pd concept.

“Using proper posture means applying a dynamic posture with a minimal load. It means sitting upright with the breastbone pushed a little forward and upward, shoulders above hip joints, while the centre of gravity is placed

above the sitting bones on a seat with a reasonable firm upholstery and a pelvic support preventing sitting with a backwards rounded back when the back muscles are tired.

“Furthermore sitting with an angle of around 105°, but preferably 110°, between the upper and lower legs, and between thighs and upper body is important so that a lumbar curve is created and is the same as the curve when standing. This is described in *Posture problems: risk or choice?*[11] However in that article there was insufficient emphasis on the dynamics of the body which would only be seen by making as many movements as possible. This is also important because the more static the sitting posture, the less proprioceptive information is gathered, so that awkward postures remain unchanged. In that situation, posture is often being determined by the non-ergonomic characteristics of equipment. So only a dynamic posture will lead to the necessary alternating contraction and relaxation of muscles and thus to proprioceptive information about balance and load of the posture. In the Beach concept the pd working posture is considered as a static posture without taking into account the dynamic aspects of a natural posture. It speaks about stabilizing the relation of the operator to the patient and a consistency of positional relationships, and then when pd conditions have been established, there will be no more need for ergonomic studies (see *e.g.* Dougherty).[4] In reality the factual information shows that a static posture leads to a higher load on the muscles, spinal column etc and less proprioceptive information by the lack of movements. So making as many movements as possible during patient treatment is absolutely necessary. It is also important to use a wide variety of positions next to the patient chair to be able to find the best combination of a good sitting position and a good view of the patient (see further), alternating the sitting positions in relation to changing treatment requirements. However the condition is that equipment should enable the dentist to work ergonomically, which is very often not the case.

“Even though a conscious use of proprioception is possible after learning to adopt a proper posture, it is difficult to assess all differences in perception of proprioception simultaneously from posture and active patient treatment. Then so much information has to be processed, for example, when attention is fully paid to hand-eye coordination for micromanipulation, which is based on proprioceptive, visual, vestibular and tactile information. Small changes of approach can be processed automatically but during more complex treatment situations it is impossible to perform micromanipulation simultaneously with posture correction based on proprioceptive information.

“It is a known phenomenon that when too much information has to be processed, stimuli primarily attracting the attention (e.g. hand-eye coordination) shut out other information; like posture, especially a static posture, where too little proprioceptive information reaches the brain. This phenomenon is called habitation or desensitization or adaptation.

“Steering hand-eye coordination under guidance of visual perception is a function of the brain brought about via instinctively evoked acquired patterns. The patterns of movements related to hand-eye coordination are acquired during growth and development and vary individually. But it is possible to increase hand-eye coordination with training. This has to start with determining the correct focal distance between eyes and fingers or working height. Another factor to reckon with is that the posture is always compulsively directed by the need to see as much as possible, with the eyeballs instinctively directed almost perpendicular to the working field. Compare it to reading a book; in this example the book is held in an oblique position such that from a comfortable reading position an almost perpendicular view on the page is possible. (One may check this by placing a book flat on a table). That is why it is necessary to turn the head of the patient in three directions to be able to look almost perpendicularly at the working field otherwise one is forced to bend with head and upper body in different directions. Here any dentist has to improvise, because there are no suitable headrests available.

“We did not find a test situation in which the handling of complicated information, like during patient treatment, is simulated and an effective use of proprioceptive self-awareness for determining an adequate posture and instrument handling, is demonstrated.

“This means that one has to reach the learned posture during the introductory actions before starting patient treatment, by positioning the patient, patient’s head, instruments, lighting and dental assistant in a way directed at the learned posture. The dental assistant has to sit properly too.

“The claim that the finger control position (zero point) or working height is positioned mid-sternal for close observation is rather theoretical. The closer one brings an object to the eyes, the more relative magnification is perceived,[18] but this leads to more strain on the eye muscles. The working distance between eyes and working field is part of hand-eye coordination. Ergonomic training of students and dentists has found that the focal

distance is located between 35-40 cm depending on the anthropometric variations of the individual, except for very long-sighted dentists. One can find this out by raising and lowering the working field in the phantom head or mouth. During the first few weeks of their training, students sometimes need to use the magnification of their eyes, bringing their eyes closer to the working field, to better observe what has to be seen and to help construct the mental pictures needed for learning dental skills.

“The kinematic chain of fingers, hands, arms, shoulders, neck and head, which incorporates the viewing direction, is based upon a balanced position, with the upper arms hanging down along the upper body and the lower arms lifted 10-15° in relation to the focal distance and supported by ring finger and little finger. The modified pen grip is used to avoid the application of the pinch grip with the instrument held between thumb and index finger, leading to a heavy load of the fingers and arm muscles. This may lead also to rotation of the lower arm and inward rotation of the shoulder joint. Together with a working field at mid-sternal height, at the level of the heart of the pd dentists, this working field is too near to the upper body. Consequently the head has to be bent forward, further than the limit of 25°[12] and the back becomes bent backwards.

“Furthermore, the upper arms lose contact with the upper body and with it their support, while the working height causes elevation of the shoulders, resulting in an increase of the static load in the kinematic chain.

“A working field that is too near also leads to an excess of eyeball depression (downwards turning of the eyeballs) that has to be compensated for, again with inclination of the skull. Furthermore the eyeballs become turned inwards. Downward and inward turning of the eyeballs is uncomfortable and tiring, causing a deformation of the eyes, together influencing visual acuity. This is bound to happen in a static situation. Dr Wolfgang Neddermeijer states that working at the midsternal height is needed for precision performance, but often this means an eye-object distance of less than 30cm. An experienced optometrist explained that close up visual acuity can be higher but that this usually does not happen, only for highly myopic people. So a working distance under 30cm is not an option. Furthermore when one brings the object closer to the eyes, the more the eye muscles are strained. This is fine for a short time, but not over an extended period.

“Meanwhile, it also appears that the discriminating possibilities of the eyes of dentists grow considerably with training (not yet published study) so that reducing the distance for unskilled activities, with the adaptation of the eyes, is not the right principle.

“So, having the working height midsternal is interfering with a balanced position of the different parts of the kinematic chain and a good vision.

“A condition for good micromanipulation is that the load needed for stabilisation of the body and for the eye muscles has to be minimal.

“However, the stabilization that is needed, couldn't be demonstrated by the use of the pd reference posture. Independent proprioceptors couldn't be found in medical/neurological literature. The training of movements in an empty room such as carrying out make belief dental treatment, as described by Neddermeijer, can even be delusive to one's own perception. Most important however is that it is a training without fitting in all faculties and facilities we need for micromanipulation.

“The pd approach is not based on anatomical and physiological principles, leading to the least load on muscles, joints and spinal column. The pd approach is confusing the present insights in dental ergonomics by using the phenomenon of proprioception in a different way to the one commonly accepted by dental and medical sciences. We fear that often the word proprioception is used, while only conscious perception is meant. There is evidence that no strong relationship exists between unconscious and conscious proprioception: they are physiologically different but have a cognitive connection.”

Concluding remarks

“Proprioception is the awareness of position and/or movement of the body and works both consciously and unconsciously as a feedback mechanism. As such it informs us about the *status quo* of the position of all parts of our bodies and takes part in automatic movements coordinated in the cerebellum. Proprioception certainly not includes an automatic ‘built-in’ mechanism leading to a proper posture, working height and finger control position.

“When learning new skills, with or without instrumentation, propriocepsis is automatically extended to the new patterns of movement. Therefore the training of these patterns should be based upon sound physiological principles, thus reinforcing a healthy working posture. Micromanipulation as performed by dentists can only be processed if they are taught to do so and this has to lead to controlled actions. The same goes for learning to play golf and so on. There is a very close connection between visual and vestibular information. Training the outcome of the combined information will lead to more sophisticated and refined automated (cerebellary) reaction patterns and thus to a better use of proprioception. At the same time individual characteristics of the human body can allow for these processes or limit them.

“The learning process for acquiring a proper posture needs further consideration especially in dental schools, also in relation to the high percentage of habitual postures and musculoskeletal complaints.”

Prof Oene Hokwerda Dr. Paul Engels

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