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Change in Form of the Spine as a Consequence of Pregnancy

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INTRODUCTION

The typical individual posture is, to an important degree characterized by the form and the position of the spine. For the sake of research into the relation between the form of the spine and its loading, an appropriate research-situation was found in the statics that existed before and after pregnancy, because here in a relatively short time a considerable change in loading occurs under the essential condition of a natural,unconstrained posture.

THEORY

With pregnancy X-ray pictures are not indicated. Description of form, therefore, is based on the dorsal contour. In what follows the dorsal contour of the spine will be understood to be the smooth line that passes through the points on the skin that are considered to represent the most dorsal points of the processus spinosi. As to the thoracolumbar area 17 points are concerned through which a curved line is drawn with the help of a digital computer by means of adaptation of a polynomial according to the method of least squares.(fig.1). In order to relate change in form to change in load, a certain analogy is supposed between the mechanical behaviour of the spine and the mechanical behaviour of an elastic rod of "technical" material(model). On this basis, concerning small changes in form the following equation is applied

$$\Delta K = \frac{\Delta M}{EI} \quad \text{where} \qquad (1)$$

ΔK - change in curvature at a certain point
ΔM - change in bending moment at a point
EI - flexural rigidity, being the product of
E - modulus of elasticity and
I - second moment of area about an axis.

The magnitudes most difficult to be defined in vivo, are load and flexural rigidity. In order to be able to get round the use of absolute values concerning these quantities, proportionalities and laws of scales are applied.

DATA SOURCE

With sixteen pregnant women the dorsal contour of the spine was measured. The measuring-apparatus contains an optical system(reflectometer) with which the positions of the processus spinosi are recorded in a system of co-ordinates [1]. The body-weight and body-length were also measured. Reproducibility was obtained by putting the heels against a wooden block, by folding the hands before the body and by applying the same direction of looking. Accuracy was increased by making measurements twice and by determining the average of them. The measurements were made both a few weeks before and a few weeks after partus, and this at the same hour of the day on the same day of the week. The women concerned expected childbirth in the same period of two weeks. With one woman ever since the fourth month of pregnancy measurements were made monthly.

RESULTS

Contrary to expectation and to the information most text-books contain, in every case, *before childbirth* the spine was *straighter than after childbirth*. Maximum changes in curvature were observed in the lumbar area between $0.9 \cdot 10^{-3}$ and $2.6 \cdot 10^{-3} mm^{-1}$ and in the thoracic area between $0.2 \cdot 10^{-3}$ and $1.0 \cdot 10^{-3} mm^{-1}$. Fig.1 shows the spinal contours of one case before(B) and after(A) childbirth. The observation that before childbirth all women were about 10 mm taller than after childbirth, was in conformity with the straightening of the S-shaped spine. Fig.2 shows the change in length of one woman ever since the fourth month.

DISCUSSION

An explanation for the straightening of the spine during pregnancy, women taking the unconstrained standing posture as described, might be found in connection with the equilibrium of moments about the hip-joint(fig.3). In standing posture the mass centre of gravity of the part of the body that is above the level of the hip-joint, lies dorsally of this joint (force F). In this context equilibrium of moments is normally realized by muscular force, on the ventral side of the hip-joint. This force is extended among other things by the Musculus Psoas(force P). When standing unconstrainedly this muscle is continuously active; as a consequence of its attachment to the spine it bends the spine. The weight in the abdominal cavity ΔG, being a result of pregnancy, disturbs equilibrium. This equilibrium can be restored by putting the trunk-weight F further dorsally. This, however, does not account for the spine being straightened. It is more plausible that proportionate to the increase of ΔG, the force P in the M. Psoas decreases, which results in a straightening of the spine. Besides, thus the femoral head is loaded to a smaller extent. Referring to equation (1) the above leads to the following derivation: Proportion between the decrease of the tension in the M. Psoas and the decrease of the bending moment exerting on the spine, yields $\Delta M \div \Delta P$. If $\Delta P \div \Delta G$, we can write

$$\Delta M \div \Delta G. \qquad (2)$$

As to I the hypothesis exists [1]:

$$I \div G \qquad (3)$$

where G stands for total normal body-weight. Assuming that during the time of research, E is constant, after the substitutions of (2) and (3), (1) becomes:

$$\Delta K.G \div \Delta G \qquad (4).$$

The relation concerning the 16 measured women has been plotted in fig.4. Δ K is the change in curvature on the spot of the **largest curvature** of the lumbar spine(at L3, L4 or L5).In connection with the regression line the three cases with exceptionally large changes in weight, have been left out of consideration. For these three cases it is assumed that the regulating mechanism according to (4), beyond a certain limit does not suffice anymore, so that for the sake of equilibrium, muscles on the dorsal side(hamstrings) should be tightened. The latter does not contribute to Δ K.

CONCLUSIONS

In themselves, the straightening of the spine and the increase of the body-length during pregnancy, are interesting conclusions from measurements. The biomechanical explanation for it, however, adds to the insight into postural equilibrium in general.

REFERENCES

1. Snijders, C.J., On the form of the human thoracolumbar spine. Ed. VAM, Voorschoten 1971.

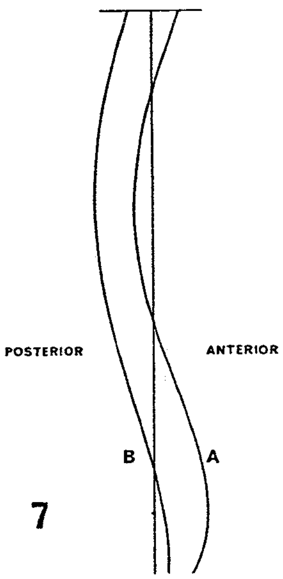

Fig. 1. Dorsal contour of the spine.
B : before childbirth. A: after childbirth. The straight line is the vertical through the hindmost limitation of the heels.

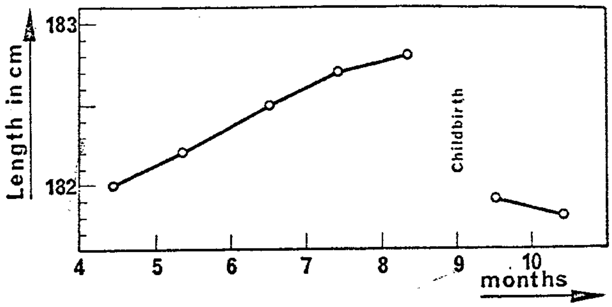

Fig. 2. Change of body-length versus time,from the fourth month of pregnancy.

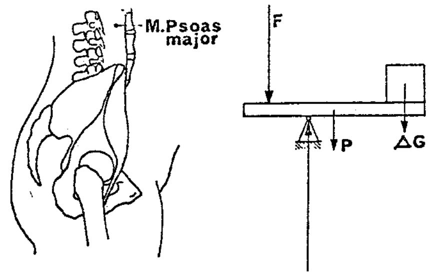

Fig. 3. Model of the equilibrium of moments about the hip-joint in natural erect posture.

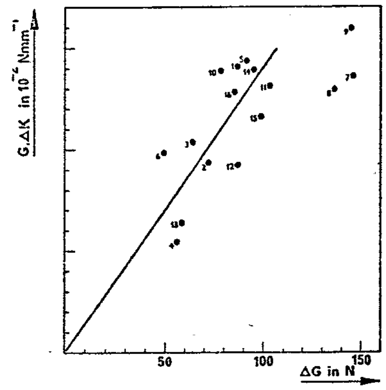

Fig. 4. The body-weight(G) multiplied by the change in curvature(Δ K) plotted against the change in weight in the abdomen(Δ G). Dot 7 concerns a pair of twins.

RESUME

Les défauts d'orthostatisme constituent un élément important pour évaluer le mal de dos. Dans ce contexte la forme et l'attitude de la colonne vertébrale déterminent la posture individuelle type. Les recherches sur les modifications de forme de la colonne sous l'influence du changement de charge considérable, encore qu'essentiellement physiologique, associé à la grossesse ont fait apparaître une situation favorable. Des mesures effectuées chez 16 femmes ont montré que, contrairement à l'idée généralement admise, la courbure dorsale de la colonne vertébrale s'atténue pendant la grossesse, d'où une augmentation de taille de l'ordre de 10 mm. Une explication biomécanique de ce phénomène est donnée, à partir de l'équilibre des moments au niveau de l'articulation de la hanche.