

Optic Posturometry

I. Introduction

Pierre-Marie GAGEY
Posturology Institute, Paris

The Posturography Society

In 1971, in Madrid, physiologists who were interested in motor control, founded the International Society of Posturography, better known today as the International Society of Postural and Gait Research [ISPGR] (1) because postural control seemed to them a special part of motor control, the static aspect of which facilitated recording.

The first congresses, from 1971 to 1979, were a real cacophony! Each participant presented his personal invention, without any attention to what had been presented before. No joint work was possible under these conditions. So much so that at the Amsterdam congress in 1979 a Standardization Committee was founded to decide which technique should be chosen to allow collaboration between all members of the Society.

The force platform was adopted as the reference technique for a joint work of Stabilometry, at the Kyoto congress, in 1981 (2).

But some authors have considered stabilometry to be a far too reductive technique since its recordings relate to only one single point: the center of pressure. Admittedly this allowed a certain rigor and measures therefore statistics, attempts at standardization (3). But the man's body was reduced to an inverted pendulum with only one degree of freedom, when in fact he has a good hundred. Optic posturography research therefore had a solid basis to justify its pursuit despite the Kyoto decision. They did not lead to useful techniques until all the photographed points on the skin could be referenced in a three-dimensional Cartesian system, thanks to known technologies and a few lines of computer programs.

Since these techniques are now usable, it is time for posturologists to get to know and use them.

Parallax, Rasters and Infrared

Astronomers have long used the observation from two different stations of a distance between two stars to measure it by the difference in

viewing angle between the two stations. By using two cameras to take pictures of the skin, it is also possible to measure the distance between any two points, in the plane of the photo (say in x and in y). The precision of these optic measurements is remarkable, less than a millimeter.

The use of light with strictly parallel rays is more recent, it allows to organize light beams in parallel layers, the rasters. Projected on the skin, they draw from another point of view as contour lines from which we measure the position of any point on the skin in the third dimension (z), orthogonal to the plane of the photograph.

This third dimension can also be measured by another technique: the difference in duration of the path of the light ray according to the difference in distance (in Z) between the camera and this or that point on the skin, the frequency of the light ray chosen being controlled, generally in the infrared range.

The fourth dimension

The body of the man standing « at rest » is in fact « in continuous movement » due to postural sway. A simple snapshot therefore captures, at random, only one position of the body. We would be condemned to know only series of random positions if Stabilometry had not allowed us to know, for the moment, that the postural sway is held within two periods:

- 1) A « mechanical » period dictated by the physical characteristics of the inverted pendulum, it is of the order of three seconds (4).
- 2) A « circulatory » period spanning approximately seven minutes (5, -7).

To take account of these periods of oscillation, in order to obtain the most reliable image possible of the mean position of the body of the man it would suffice, for example, to make an average of positions on photographic recordings taken at a rate 0.25 Hz for seven minutes. The sampling period is chosen arbitrarily, to limit the risks of falling on the same phases of the « mechanical » period at the time of the different snapshots.

For Von Rolbeck, the economic stabilization of the body is ensured by the « work of the feet », because the work of the other joints and the spine would have less impact on the speed of the postural reactions.

Presentation of the results

A choice is essential to present the measurements of this set of skin coordinates. We can define parameters — on what criteria? —, present diagrams gathering characteristic points, represent the skeleton by relying on the modeling that it imposes on the skin. This last technique is already

implemented for the spine (8-12), it represents 17 vertebrae, each in the position authorized by its 4 degrees of freedom.

Unfortunately, the modeling of the soft parts of the neck by the cervical vertebrae does not allow to represent them, therefore to verify the importance of the position of C1 and C2 on the position of the rest of the column.

Critic

The Power of the Image

We can never say enough the power of the image in our psychic life. The image by its very structure is immediately in perfect agreement with the functioning of our imagination which proceeds by association of images as its name itself indicates. There is no need to rework the image to make it effective, it is. It is immediately integrated into the abundance of activities that characterizes our imagination, without stop day and night. It suffices « from a sustained presence of reason within its consent to the imaginary. »(13) for the magic of the image to appear: its ability to bring out new concepts. It then manifests its victory over the hegemonic tendency of reason which tends to make us reject the imaginary and confine ourselves to the « proven » (14).

We can therefore only congratulate ourselves on the abundance of images, it augurs us for a rejuvenation of Posturology in front of this avalanche of representations of the very thing which lead us to go beyond our well-established objects of knowledge, but for as much reduced only to what has a connection with the proven rational.

One aspect of this rejuvenation of postural therapies thanks to these images of the spine seems already present in the representation of the Mézérienne muscular chains (15) as of shrouds of the spine that the manipulations of the inputs of the upright postural system allow to tend more or less. Cécile Vandame has not yet written anything on this subject but she should get started, without forgetting the role of the fascia.

The presence of reason

But, on the side of the presence of reason, many problems appear. Before embarking on the interpretation of an image it is reasonable to first make sure that it has a meaning. Is this variation that I observe between two images, after and before manipulation, simply due to chance? Does it have a real correlation with the manipulation in question? Current clinical experience suggests that it is reasonable to believe, but this remains to be proven.

Would such work be possible? André Thomas and Julian de Ajuriaguerra thought that not "The tone varies at all times, it is continuously in play ... all peripheral excitations, of whatever nature, are capable of causing tonic reactions" (16). We have shown that postural reactions are not random (17), so it seems possible to admit that the regulation of postural tonic activity is sufficiently organized for studies of repeatability of postural phenomena to be possible.

A first question underlying this type of study seems obvious: how to approach the repeatable while rejecting the normalized? The study of a repetition makes no sense if the two examination situations were not identical... However, a great wealth of optic Posturometry consists precisely in not imposing a standardized position - the bone of contention of the stabilometry! -. But, in fact, we do not have the right to eliminate a priori the hypothesis that the subject can spontaneously return to the same position of comfort and this is perfectly verifiable at the level of the feet by an analysis of their images.

There remains the problem of the fourth dimension: recording for seven minutes... This is obviously impossible in clinical practice; moreover, would it make sense? At this time level, Stabilometry regains its rights by the drastic reduction that it operates in degrees of freedom ("Who embraces too badly embraces").

Disregard the movements of the body due to venous return despite their importance, after all why not? Clinical stabilometry has already decided to do so by limiting its recordings to 30 seconds to increase its chances of the record remaining within a one-minute oscillation (6).

But that's a lot of problems.

The global postural clinical examination

Despite all these problems which remain undoubtedly unresolved for a long time, Optic Posturometry indisputably improves our overall approach to patient posture. Even if we don't yet have a picture of the whole skeleton, even if a seven-minute recording is hardly possible, the method is useful.

As a counterpoint to this global approach, it is good to recall the limits of the postural clinical examination developed at the Institut de Posturologie de Paris, in the 1990s. The principle of this examination consisted in verifying whether the trajectory of the movement around of one or a group of joints conformed to the geometry of the articular surfaces. If this was not the case, then check whether this trajectory was corrected by manipulation of inputs from the upright postural system. Effective manipulation, especially if it was on several trajectories, was then supposed to be able to be effective on the overall posture of the

patient, blindly! ... since we had only very limited and not very rigorous access to this global posture.

Conclusion

The developments of its optic techniques have considerably enriched Posturography, even if they still need to be improved. It is possible and it is time that therapists began to use them widely and developed a language about them.

Bibliographie

1. Baron J. History of posturography. In: Igarashi M, Black F, editors. Vestibular and visual control on posture and locomotor equilibrium. Basel: Karger; 1983. p. 54-9.
2. Kapteyn T, Bles W, Njikiktjen C, Kodde L, Massen C, Mol M. Standardization in platform stabilometry being a part of posturography. *Agressologie*. 1983;24(7):321-6.
3. A.F.P. Normes85. Paris: ADAP; 1985.
4. Bizzo G. Tentative de détermination de la fonction de transfert du système de régulation posturale chez l'homme en orthostatisme à la suite de stimulation électriques labyrinthiques: Paris V; 1974.
5. Gagey P. Introduction to the Russo-Japanese revolution in stabilometry. *MTPRehabjournal*. 2018;16:684-6.
6. Inamura K, Mano T, Iwaze S, editors. One minute wave of body sway related to muscle pumping during static standing in human. *ISPGR*; 1990; München. Stuttgart: Georg Thieme; 1990.
7. Usachev V, Gagey P. The postural system as a functional venous pump. *MTPRehabjournal*. 2018;16.
8. Frobin W, Hierholzer E. Rasterstereography : A Photogrammetric Method for Measurement of Body Surfaces. *Photogramm Eng Remote Sensing*. 1981;47(12):1717-24.
9. Frobin W, Hierholzer E. Calibration and Model Reconstruction in Analytical Close-Range - Stereophotogrammetry, Part I: Mathematical Fundamentals. *Photogramm Eng Remote Sensing*. 1982; 48(1):67-72.
10. Frobin W, Hierholzer E. Calibration and Model Reconstruction in Analytical Close-Range Stereophotogrammetry. Part II: Special Evaluation Procedures for Rasterstereography and Moire Topography. *Photogramm Eng Remote Sensing*. 1982;48(2):215-20.
11. Stokes I, Armstrong J, Moreland M. Spinal Deformity and Back Surface Asymmetry in Idiopathic Scoliosis. *J Orthop Res*. 1988;6(1):129/37.
12. Tabard-Fougère A, Bonnefoy-Mazure A, Hanquinet S, Lascombes P, Armand S, Dayer R. Validity and Reliability of Spine Rasterstereography in Patients With Adolescent Idiopathic Scoliosis. *SPINE*. 2016;42(2):98-105.
13. . Gagey J. Gaston Bachelard ou la conversion à l'imaginaire. Paris: Marcel Rivière & Cie; 1969. 304 p. Nouvelle édition Kindle, 2019.
14. Masquelet AC. What proof do we have evidence based medicine has brings a true benefit? *Acad Ntl Chir* 2010;9:279-31.
15. Denys-Struyf G. Le Manuel du Méziériste. Frison-Roche, Paris, 1996
16. Thomas A, de Ajuriaguerra J. L'axe corporel. Musculature et innervation. Paris: Masson; 1948. 538 p
17. Gagey P, Asselain B, Ushio N, Leconte M, Baron J. Are the asymmetries of the orthostatic posture random? . *MTPRehabjournal*. 2018;17:687-93.