NEUROPHYSIOLOGICAL STUDY OF THE E-MOTION

H. Godard*, C. Pirovano°, L. Bedodi°°, A. Cola°°, G. Galperti°°, R. Sensi°° and G. Martino°

* Université de Paris VIII Saint Denis.
° METIS - Medicine and Memory - International Center of Studies and Therapies for Women's health - Milan
°°Rehabilitation Dept. - National Cancer Institute - Milan

INTRODUCTION

Research conducted over the course of eight years on the physical and psychological damage in women operated on for breast cancer led us to study some inexplicable phenomena related to the oncological trauma and to the surgery (1-3).

We found post-surgical limitations of the shoulder girdle in daily movement that could not be explained through muscular, articular, electromyographical and radiological examination. In the classical clinical approach, only the force and amplitude of the basic movements of the joint are measured.

Observation of the subjects while walking and while performing the movements of daily life revealed changes in the coordinative structures (acquired sensory-motor automatisms) that were not reflected in the voluntary action tests. When walking, 65% of the breast-operated women showed a loss of pendular motion of the homolateral arm. From the observers' perspective, the arm looked anchored to the trunk or paretic (like dead). When asked to move the arms symmetrically while walking the patients performed the movements without difficulty. In most cases the loss of pendular motion of the arm when walking, causes over time and by compensation, a malfonction of one hip joint.

A second series of experiments was carried out with patients in the pre-operative phase and with a sample of healthy women; 50% of the women with breast cancer in the pre-surgical period presented reduced pendulousness in comparison with 10% in the healthy group (4). The pendulousness further decreased after surgery, in some cases as far as complete arrest of the arm.

A third series of experiments was conducted with post-surgical subjects, without functional or articular deficit, participating in body-mind therapy groups (immediately post-surgery and during subsequent radiation therapy). We observed that these patients had less ability in space directionality [exteroception] (5), in space projection [ex-proprioception: Awareness of body positions in reference to the spacial surroundings] (6) and in the ability to anticipate an action with the arm on the side of the operated breast.

Following Damasio (7), Edelman (8), Reed (9), we suspected a link between emotion, perception and the loss of movement in our oncological patients.

Starting from these works we investigated, through a new trial with the EMG, the neuro-physiological implications of the emotional situations and of the fluctuations in perception in the context during the movement (e-motion).

Specifically the aim of this study was:

- to understand the relationship between the strength in the motion and the organization of the projection in space ;
- to evaluate the importance of the balance between proprioception and exteroception as crucial anticipatory factors of the movement;
- to focus on the implication of the relational context regarding the subject during the classical diagnostic-prognostic electromyography;
- to improve the techniques of rehabilitation by paying attention to the individual's emotional perceptual organization.

MATERIALS AND METHODS

The experiment was carried out on 10 healthy volunteer subjects: 5 men and 5 women, aged between 28 and 46 years and without previous neuro-motor deficits. We chose to evaluate the overall capacity of extension of the forearm against resistance in several different contexts.

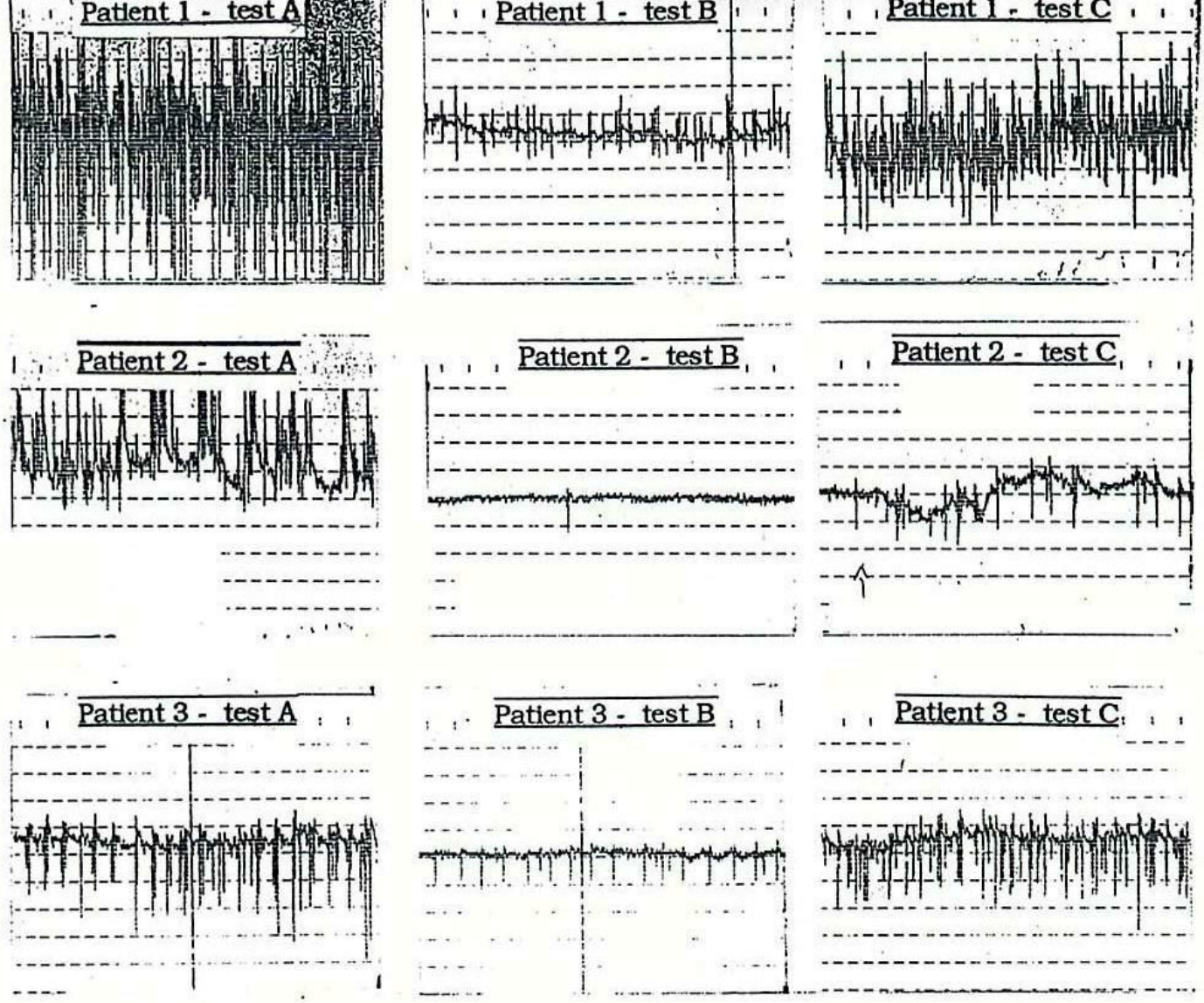
Strength of extension of the forearm is based on the work of the triceps brachi which can be inhibited or facilitated by the action of the antagonist: the biceps brachi. The stronger the work of the antagonist, the weaker the overall capacity of extension. The amount of biceps action is thus taken as the indicator of an inhibition in the movement.

The triceps could be considered a muscle with a clearly prevailing phasic, alpha mediated activity and it has, as antagonist, the biceps, a muscle implicated in the gravitational equilibrium with an important gamma activity. The two muscles could be considered "pure" antagonists because the articulation of the elbow is structured in way that allows few additional
movements during the flexion-extension of the forearm.

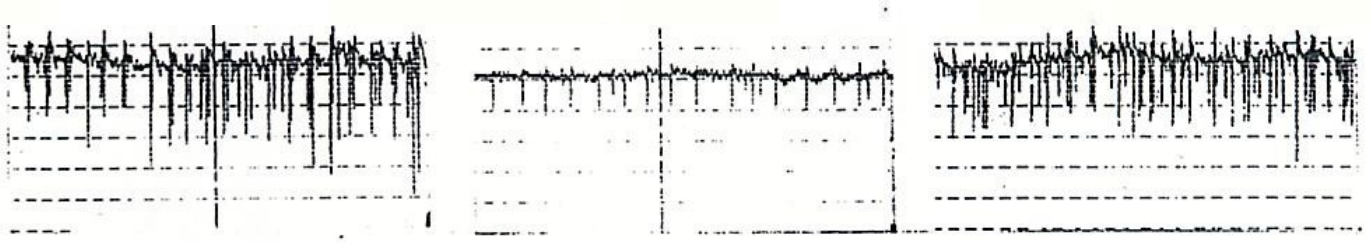
The neuro-physiological investigation was carried out with electromyography, by concentric needle electrodes of Adrian and Bronk. The recruitment pattern was recorded continuously during maximum voluntary activity, with sweep speed of 20 msec. And amplitude of motor units of 0.2 mV per division. [Some examples of the electromyographical traces that were recorded are shown below]

Subjects, in seated position, were asked to support the back of the wrist on a bracket and to maintain the extension of the forearm resisting the examiner's attempt to flex it. (test against resistance).

- Initially the request was to exert the maximum possible extension of the forearm against resistance (test A).



Three patients in the test A,B and C



Three patients in the test A,B and C

DISCUSSION

In the A-test the electrical activity registered in the biceps brachii (antagonist muscle during the maximum extension of the forearm) could not be caused by the will of the subject who is actively trying to obtain the maximum motor performance. The electrical activity of the biceps could be explained by the tonic-emotional arousal (increase of the gamma tone) linked to the context of

struggle during the extension of the forearm which modifies the proprioceptive/ex-proprioceptive balance necessary for efficient movement. Without an exproprioceptive reference, the subject no longer perceives the reality of the actual context (which includes the external) but only the relationship with the examiner (A-test:emotion).
Since the two muscles contract together, a part of the pure extensor activity of the triceps is lost in the conflict with the flexion of the forearm induced by the biceps. In other words, a part of the potential energy of the triceps has been transformed into caloric, not productive energy (entropy) instead of being used for the movement .

In the B- test the addition of a clear exproprioception before and during the movement ameliorates immediately and often completely the situation in the observed subjects. Clinically the examiner registers the maximum strength of the triceps and the EMG reports the electrical silence of the biceps. This is due to a better relationship between proprio /ex-proprioception. When we introduce the projective and aiming element we suppress or clearly reduce the gamma activity of the biceps, while the triceps becomes wholly constituted from kinetic pure energy (alpha). We can say that the ability to project in the space suppresses the unconscious inhibition, the unaware activity that conflicts with the voluntarily programmed action. The relationship is then triangulated for the examinees who feel their arm, face the examiner and relate to the surrounding. This situation brings them to the maximum potential of action (B test: ex-motion).

In the C - test, the evidence, in most cases, a reactivation in the biceps brachii simultaneously with the reduction of the spatial projection, confirms the influence of the subject's evaluation of the context and the symbolic dimension (conscious and unconscious) on the tensional organization of the shoulder girdle. Over time this situation of poor spatial projection (absence of projects for a part of the body) decreases the sensorial afference stimuli and leads to a structural modification of the related primary sensory cortex's territory. Merzenich et al. (10,11) demonstrated the rapidity of the transformation of these territories in absence of the afferent stimuli. The impoverishment of the sensory cortex then decreases, in its turn, the ability of the motor cortex's retroactive loops linked with the sensory area. The work of these retroactive loops represents, according to Weisendanger (12), 98.5% of motor cortex activity. Thus a vicious circle is formed which can progress as far as the complete disappearance of a motor activity without any evident somatic injury.

CONCLUSION

We registered, with EMG, the different potentiality of the muscular activity submitting the subjects to motor resistance in various perceptive/projective tests. When we ask the subject to only counteract the examiner we noticed a paradoxal electrical activity in the antagonist muscle which reduced the strength potentiality and brought rapid fatigue. The relationship was only oppositional and dual because of poor exteroceptive references (emotion).

Without spatial attention, a weak force was registered. This is due to the emotional situation that elicited an accentuation of the gamma activity increasing the spindle response (modification of the firing point of the stretch reflex by the gamma loop) of the antagonist muscle.

When we ask the subject to extend the forearm with adirectionality and a spatial projection of the hand, we registered the full strength of the agonist muscle, with absence of activity of the antagonist. The action by the exteroceptive and exproprioceptive references became triangulated and therefore potentially maximized (ex-motion).

This EMG study helps us to understand why many of the oncological patients that we observed lost some basics movements without clinical explanation. This loss came from the reduced capacity to have movement projects of a part of the body due to the physical and emotional trauma in this part. Over time, the repetition of this situation transforms sensory organization (transformation of the body image) and then motor capacity. Our neuro-physiological results emphasize the importance of considering the role of sensory activity in motor rehabilitation; clarify the relationship between the quantity of muscular strength and the quality of the projection in the space (proprioception and emotion / ex-proprioception and ex-motion); calls into question the value of the standard approach of
studies using EMG that disregard the importance of the context during clinical evaluation; emphasizes the importance of a program of rehabilitation that gives attention to the patient's e-motional/perceptual organization.

BIBLIOGRAPHY

1. Martino, G. Prevenzione e terapia degli esiti. In: U. Veronesi (ed.): Manuale di senologia oncologica. Milano: Masson, 1993, pp. 431-442.
2. Martino, G. Il recupero del paziente oncologico: aspetti psicologici e riabilitativi. In: G. Beretta, E. Ghislandi, G. Luporini, A. Scanni (eds.) Atti del XV Corso di Aggiornamento in Oncologia Medica. Milano, 26-29 giugno 1994.
Milano: AIOM, 1994, pp. 439-443.
3. Merson, M., Pirovano, C., Balzarini, A., Luini, A., Biasi, S., Galimberti, V., Genitoni, V., Muscolino, G., Veronesi, P. The preservation of minor pectoralis muscle in axillary dissection for breast cancer: functional and cosmetic evaluation. Eur. J. Surg. Oncol. 18, 215-218, 1992.

4. Godard, H. Le geste manquant. In: Revue Internationale de Psychanalyse, Etats de corps, Ed. Erès, Paris, 1994, pp. 63-75
5. . Lee D.N.: On the functions of vision. In: H. Pick and E. Saltzman (Eds.) Modes of perceiving. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1978.
6. Fitch H.L., Tuller B., Turvey M.T.: *The Bernstein Perspective: III. Tuning of Coordinative Structures with Special Reference to Perception.*
In: J.A. Scott Kelso (ed.) Human Motor Behaviour: An Introduction. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1982.
7. Damasio A. R., *L'erreur de Descartes*, Editions O. Jacob, Paris, 1995
8. Edelman G. M., *Biologie de la conscience*, Editions O. Jacob, Paris, 1992
9. Reed E. S., *An outline of a theory of action system*, Journal of motor behavior, Vol. 14, N°2, 98-134, 1982
10. Wall J.T., Kaas J.H., Sur M., Nelson R.J., Felleman D. J. and Merzenich M.M. *Functional reorganization in somatosensory cortical areas 3b and 2 of adult monkeys after median nerve repair: possible relationships to sensory recovery in humans.* J. Neuroscience 6, 218-233, 1986.
11. Merzenich, M.M., Recanzone, G. H., Jenkins, W.M., and Nudo, R.J. *How the brain functionally rewires itself*. in Arbib M.A., Robinson J.A. : Natural and Atipical Parallel Computation, Mit-Press Cambrige, 1990 , pp 177-210.
12. Weisendanger M. "*Contrôle cortical des mouvements et régulation par les afférences proprioceptives*" Journal de physiologie, Paris, 1976

All the Authors have worked (and some are still working) at the Rehabilitation Department of the National Cancer Institute of Milan where for more than twelve years they have worked to ameliorate the quality of life of people with cancer. Hubert Godard directed a seven year training program for the rehabilitation team of the INT on bio-mechanical, functional and symbolic aspects of movement. He led this research which was financed by the CNRA.C.R.O n. 92.02361 coordinated by Gemma Martino.