POSTURE AND INTER-SYSTEMIC BODY CORRELATIONS

MULTIDISCIPLINE APPROACH WHEN DEALING WITH POSTURAL – CRANIO – MANDIBULAR DISTURBANCES

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Pathologies correlated to disturbances of the Postural Homeostasis

Often doctors resort only to the observation of patients affected with unascertainable painful dysfunctional type problems at different levels. These cases are sometimes treated generically or by a specialist using therapies which, being more symptomatic than random, often result with a relapse or are unsuccessful. With time, such profiles of the syndromes, above all at the onset of the functional changes, tend to determine damage of an anatomical-structural type, which is not always reversible, and involves even the psycho-emotional sphere of the patient.
In such a situation some ailments like the lack of balance of the body asset, change in the static and dynamic assets of the lower limbs, painful and dysfunctional pathologies of localised or diffused joint and myofascial levels, tendonitis, muscular–tense neuralgia, instability and deviation of the equilibrium, visual disturbances (ex., heaviness and eye pain, reading tiredness, dystonia eye-movement, dysphoria), tinnitus- ringing in ears, nocturnal/diurnal para-functions in cranio-mandibular areas (ex., grinding of teeth, tightening), sleep disturbances, neuro-vegetative disturbances and so on.

POSTURAL HOMEOSTASIS AND CORRELATED MODALITIES BETWEEN THE VARIOUS AREAS OF THE BODY

Numerous clinical and instrumental studies in the bio-mechanic and neurophysiological research field (see biographical appendix) have shown how a functional organisation of the body can be achieved through a cybernetic model which is typical of a ***Complex system equi-functional to total and calibrated responses***.
The system is defined ***complex*** as it is made up of many sub-systems whose correlations are unrelated between themselves; ***equi-functional and total response,*** as their sub-systems always react in an overall and synergetic way to the changes of external and internal entrances for carrying out normal functions; ***calibrated,*** insomuch as they are able to produce continuous and coherent (outputs) responses to adjustments to the various arrivals/onsets coming from the environment (inputs). Thus the system is guaranteed with its "essentiality" , that is keeping the vital physiochemical type parameters constant (ex., hematologic chemical values, blood pressure…), thermodynamic type (ex., body temperature), biomechanical type (ex., the equilibrium) implementing in short the ***GENERAL HOMEOSTASIS THEORY*** **.**

This complex and synergetic interaction of the various sub-systems and body areas which contribute various kinds of afferent receptors (visual, oto-vestibular, exteroreceptors, proprioreceptors) also contribute to the achievement of a particular type of ***HOMEOSTASIS,*** in other words of the ***POSTURAL HOMEOSTASIS.***

The ***HOMEOSTASIS*** or ***POSTURAL CONTROL*** can be defined as the complex sensorial-motor mechanism of continual responses in terms of the body-spatial static - motor asset (Posture) and body-forces (Dynamic asset) to the requests of the external-internal environment, imbued with the laws of the static-dynamic Equilibrium, of psycho-physical Comfort and of Energy saving.

The posturology is the discipline that regards kinematic correlations (body spatial stato-dynamic organization) and kinetic parameters (ground reaction forces, muscular forces) appropriate to the requests of the external-internal environment, imbued with the laws of the static-dynamic Equilibrium, of psycho-physical Comfort and of Energy saving.

As already stated, to achieve the ***POSTURAL HOMEOSTASIS*** a number of sub-systems are necessary and which can be divided into four basic groups (Fig1-Fig 2):

1. *Spatially structured bio-mechanic components.*
   The bones, muscles, fascial –tendinous –ligamental components belonging to their own somatic and visceral circles where these can be found spatially organised in the sub-systems (ex., mandibular-cranio area, acromion-shoulder-sternal cingulum, relay-vertebral sub-system, pelvic plane, lower limbs and ankles) which are correlated and function like many rings in a single ***CLOSED KINETIC CHAIN*** in which any force or disturbance operating on a single segment of the system inevitably spreads to all the others.

2. *Metabolic components*
   All the biochemical mechanisms are included here – endocrinologies which govern trophism and nutrition of the whole human biological function.

3. *Peripherical neurological components*
   Self-receptive, ester-receptive, enter-receptive, visual, oto-vestibular sub-system receivers are included here.

4. *Central neurological components*
   The bone marrow, sub-cortical and transporting cortical form and integrate peripherical information transforming it into a continual flow of an appropriate and adequate movement efferent which also forms the basis of the psychic dimension of the subject. In particular, converging in the sub-cortical centres are the lateral nuclear vestibular of Deiters, the reticular substance and the proprioceptive-outside receptive afferents of many body areas (lower limbs, pelvic, trunk, upper limbs, mandibular-cranio-cervical

zones, eye-movement muscles….). Branching off from this multi-sensorial pool of convergence are the movement efferent vestibular and the spinal reticulum regulating the tone of the postural musculature which helps to understand how changes in the onset information of one or more of the above mentioned sensorial areas can determine wide-scale and different alterations of the mechanism of the neurological control of the corporeal postural asset.

The complex homeostatic corporeal system which governs the maintenance of the vital parameters and of the homeostatical postural functions is equipped in various ways from one person to another at birth, with a level of *Adaptation Capacity* that forms the *Range of Tolerance* which is characteristic and different for every human being (described by Selye in the G.A.S. that is the *General Adaptation Syndrome* of the stress-gene factors).
Such a *Range of Tolerance* allows for compensation up to certain limits and conditions to some unbalanced factors which come from the outside or inside of the body. Whenever an abnormal fall of the *Adaptation Capacity* of the body arises or disturbing agents that are excessive in their intensity, quantity or duration present themselves, the physiological limits of adaptation of the bio-system may be surpassed and a series of disorders and abnormal primal functions followed by localised or overall structural disorders could appear.

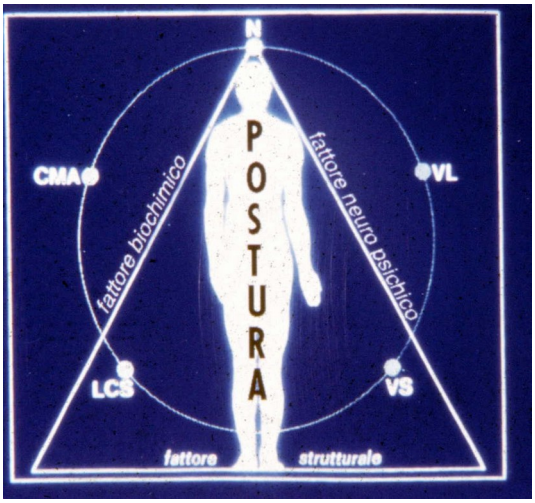


Fig.1 The main components of the postural homeostasis

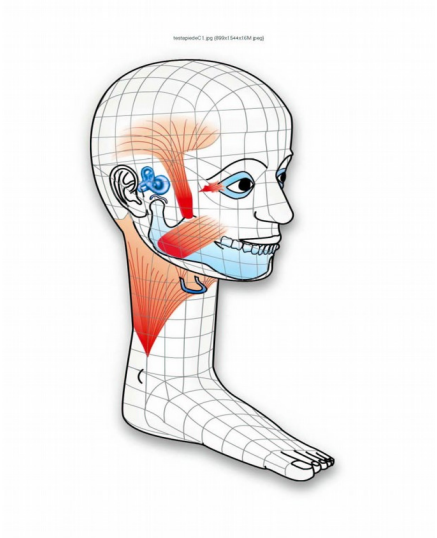


Fig.2 The sub-systems involved in the control of the posture

MULTIFACTOR ETHIOPATHOGENETICS OF POSTURAL PATHOLOGIES AND THE IMPORTANCE OF A MULTIDICIPLINE APPROACH

The characteristics and modality of the cybernetic-global reactions of our body system impel us to ask ourselves, when disorders develop, if these are indications of noxae pathogen centred in the manifestation of the symptoms or are, instead, the remote results of an imbalance that began in the deepest areas that require exploration not only from a diagnostic but also from a therapeutic point of view of a wide and integrated multidiscipline type.
It is only through a close bio-mechanic link between the areas according to the *Closed Kinetic Chain* and the complex correlation and *neurological convergences* of the various neuro-afferent components of the body (visual receivers, oto-vestibular, extero-proprioceptive receivers, psyco-receivers, pain-receivers) pooled or in common sotto-cortical centres (ex., reticular substance, cerebellum, vestibular nucleus..), is it possible to understand the end mechanisms which are at the base of some kinds of algic-dysfunctional manifestations in various parts of the body (ex., lower limbs, pelvic, lumbar region, dorsal, cervical and mandible-cranium) that are difficult to interpret and which often regress to symptomatic therapy treatment.
An accurate postural exam is therefore of the utmost importance to know the bio-mechanic and neurological factors which can influence and determine changes and disturbances, that are first of all operative and then anatomical, weighing on the locomotor apparatus and the connecting tissues of the organism (fascial) triggering off a lack of spatial balance of the body, dystonia and dyskinesia of the muscles and pain (trigger and tender points) with joint reshaping. (Fig.3)

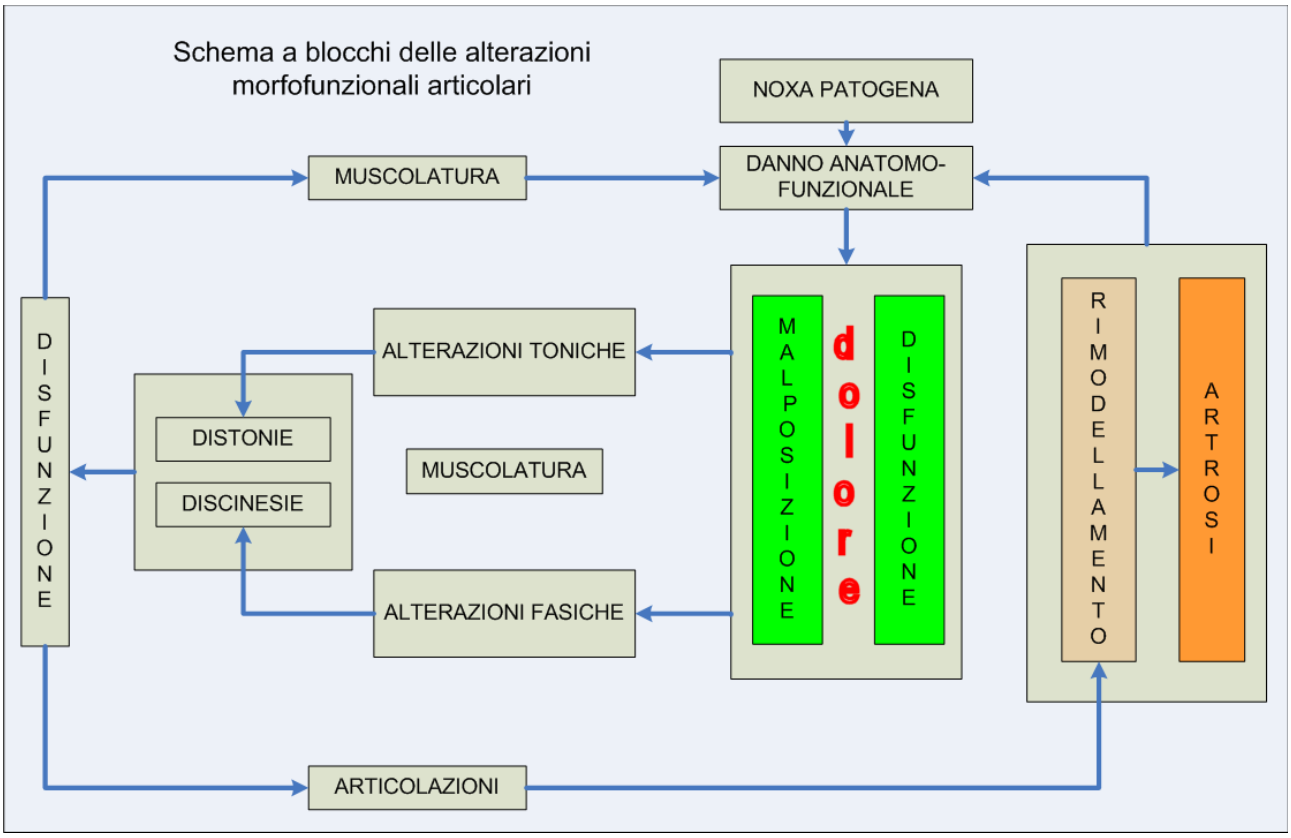


Fig.3 Scheme in blocks of the morpho-functional joint alterations

Cases of the “descendent” type may be presented for observation in this way, cases where the source of the disorder may be localised at the closest kinetic cranium corporeal level of the rings (ex., badly closing teeth, eye muscle movement disorder, equilibrium organ …. etc) which, in time, bring about adaptation, compensation and then unbalance of the lowest rings of the chain (cervical pain, lumbago) triggering off functional disorders and pain in areas sometimes even far away from the initial location of the pathology.

In the same way, but in the opposite sense, problems of equilibrium in the caudal sectors (ex., podalic) can determine higher level pathologies thus defining them as cases of the “ascendant” type.

When the two types of pathogenic actions are combined the cases are called “mixed”.

It is necessary to bear in mind that another factor could be taken into consideration as the cause of a state of functional unbalance: one which attacks the metabolic and neuro-psychological state of the subject.
These are the components which, starting from different points, diversifying from one person to another, the reaction to the noxae pathogen or other therapies arrive even to determine “sine materia” infections that are curable only in the field of psychosomatic medicine or in neuropsychiatry.

From these assumptions comes the need of an holistic-multidiscipline approach when facing postural problems and the use of rigorous and tested clinical and instrumental methods, together with an organised staff of operators in various fields (orthopaedic surgeons, rheumatologists, otoneurologists, ophthalmologists, odontologists, psychologists, rehabilitation therapists, chiropractors, osteopaths, bio-engineers….) working together in close cultural and synergetic syntony.

REASONS AND MODALITY OF A MULTIDISCIPLINE APPROACH FOR THE STUDY AND ANALYSIS OF THE POSTURE

In virtue of the already mentioned multi-systematic convergences in the aetiology of the arthro-myofascial body unbalance, basic diagnostic screening is necessary and must be widened to the largest possible evaluation of the different sub-systems that collaborate to the achievement of a biomechanic and neuromuscular body equilibrium.
Naturally it is important, in an analysis and study context of a multidiscipline type which regards many branches of general and specialist medicine (general medicine, physiatrics, orthopaedics, rheumatology, algology, neuropsychiatry, otovestibulogy, odontology, ophthalmology, paediatrics, geriatrics, motory sciences, physiotherapy, medicine of sport, medicine of work and ergonomics, legal medicine, bioengineering… etc), to create a complete procedure and language of common and shared examination. This can only be achieved through a clinical methodology (clinical-anamnestic valuation file) and through instrumental analysis which in their basic configuration (**1st Level**) can be used by the majority of the operators in the sector.
After a first general diagnostic orientation derived from the basic screening, appropriate procedure and more complex, specialist in-depth studies of the **2nd level** can be made. This kind of multifactor, integrated analysis methodology was completed and has been used for many years by the medical-engineering staff in the Research Centre Istap (Istituto di Analisi della Postura) in Florence, Italy in the form of clinical and instrumental software.

Fig.4 Research Centre Istap, Florence

This integrated multifactor analysis protocol includes:

1st level basic clinical-anamnestic approach
Valuation by score using a clinical-anamnestic file

Instrumental approach using equipment at 1st level
by means of simple and low cost technology capable of registering spatial-body asset parameters, the distribution of the strength-weight on the ground, and the registration of the area of foot placement in an orthostatic position.

Instrumental approach using equipment at 2nd level
by means of technology capable of kinematic parameters analysis of both static and dynamic spatial-body positions and kinetic functional parameters analysis that allow for an objective evaluation of the body posture, function of the equilibrium, of the foot placement on the ground in ortho-statism and in gait, of the movements of the rachis and of the function of the mandibular-cranium apparatus (optoelectronic telecameras, ground reaction force platforms, electromyographic and electrognatographic instruments).

The description of the clinical-instrumental analysis procedure of the 1st level and of the instrumental analysis of 2nd level is given in the following pages. It takes into account however that in some cases there may be a specific indication only for some cases, while in others, the more difficult and those with uncertain aetiology, it is advisable to carry out as many articulated analysis' as possible according to a well defined objectives plan which can be decided at the time with the patient's general doctor.

BASIC CLINICAL APPROACH 1ST LEVEL

The anamnestic clinical approach of the multidiscipline type, which could be either on paper or electronic, represents a useful instrument for every kind of general or specialist operator in the health service (in the fields of physiatrics, orthopaedics, rheumatology, oto-neurological, odontologics, legal medicine, medicine of sport, ergonomic and medicine of work.. etc) permitting them to have a common language. The completion of these files allow for a first screening and a basic check-up where the presence of possible pathologic interferences from one or more integrated sub-systems of the postural balance can be seen.
With this data it is possible to proceed to an evaluation by points (scores) permitting the data base to be updated for statistical studies and for an exchange of data among the operators.

ANAMNESTIC FILE: COMPILATION OF THE ANAMNESTIC HISTORY OF THE PATIENT IN SUB-SYSTEMS

AIM: To understand, in order of importance, the reasons for the patient's visit. Ask, in a rational manner, the questions concerning time, modality, characteristics of the signs and symptoms of the malfunctioning at various levels by saving each of these questions in a sub-system.

METHODOLOGY: Following up the questions and consequently filling in the various parts of the file, specifying the seriousness of the signs and symptoms of the pathology.

DATA PRESENTATION: The file presents, together with the questions, special spaces for the gravity of the pathology at various levels (mild, medium and grave) thus permitting, after compilation, to have a graphic summary of the main sub-systems involved. (Fig.5)

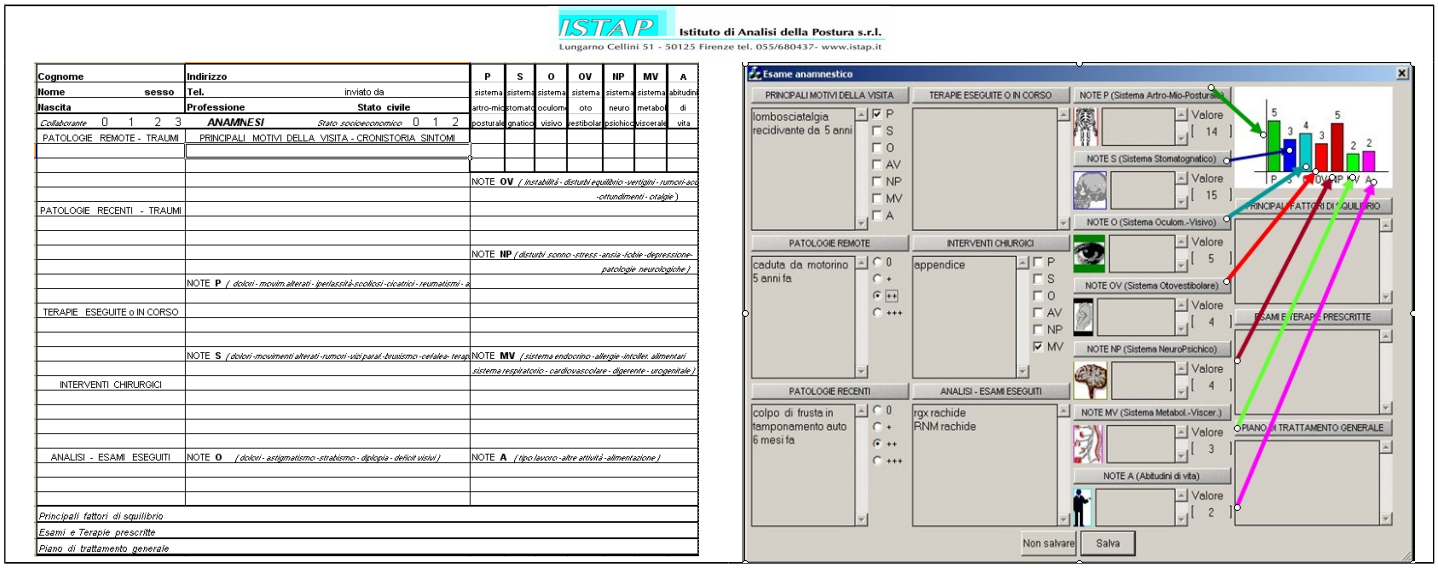


Fig.5 Anamnestic file ISTAP

CLINICAL FILE: MEDICAL VISIT REGULATED BY THE SUB-SYSTEMS

AIM: Carry out a normal “basic” clinical exam by evaluating the main sub-systems involved in the postural imbalance (arthro-myofascial systems), visual systems, vestibular, mandible-cranium, neuro-psychic …..etc) and effect some tests of the differential diagnostic type to verify the influence of the various sub-systems in the postural homeostasis.

METHODOLOGY: The operator follows the clinical analysis protocol in the file relative to the sub-systems pertaining to him as a specialist or other and, noting down the anomalies or the alterations, he can completely or partially fill out the file.

DATA PRESENTATION: The file can be completed on paper or managed by software capable of awarding a score for each clinical disorder.
The results of the clinical evaluation and of the tests involving the various sub-systems such as the arthro-myofascial (Barrè test, big toe test, dysmetria, scoliosis…. etc) the visual oculomotor (convergence test, the pursuit test, Cover test), the oto-vestibular sub-system (Romberg and Fukuda test), the stomatognathic sub-system, the neuro-psychic (scale of evaluation of stress, anxiety-depression) and the visceral sub-system (Fig.6).

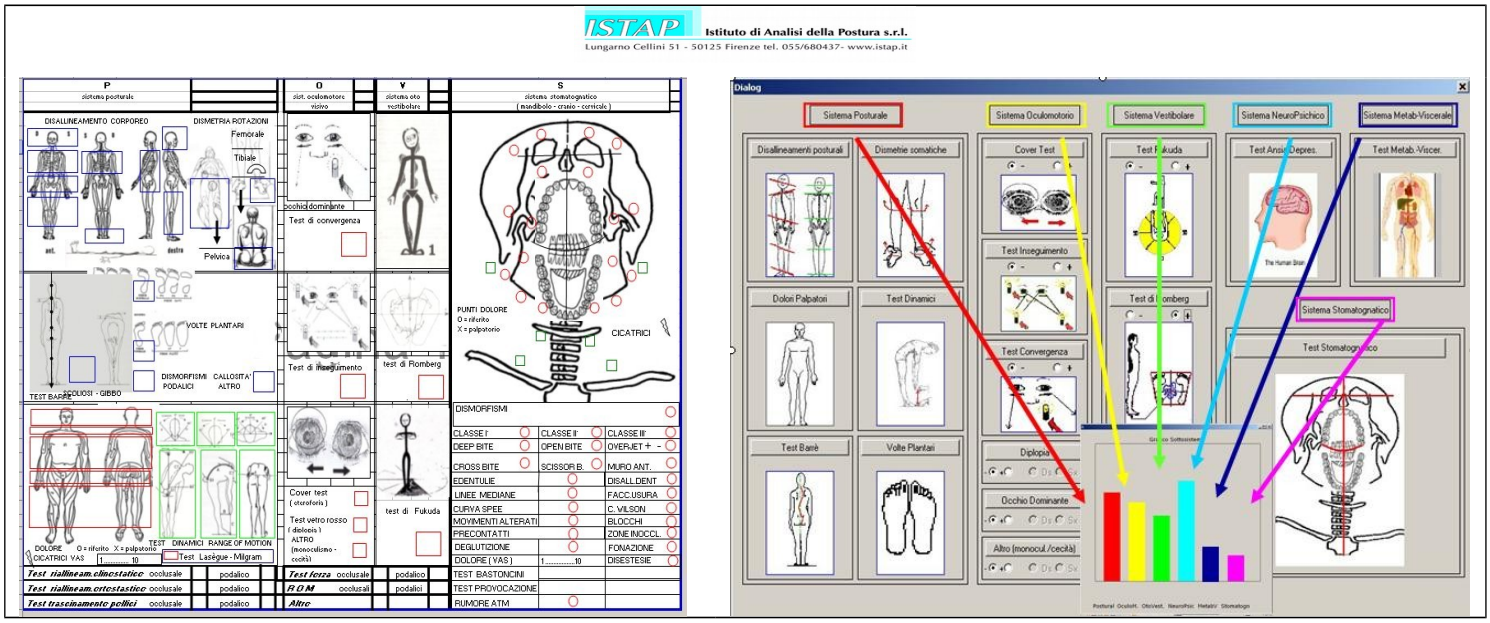


Fig.6 Clinical File ISTAP

1ST LEVEL INSTRUMENTAL APPROACH

SOMATOSCOPE: 2D DIGITAL ANALYSIS OF THE COPOREAL-STATIC SPATIAL ASSET

AIM: Determine the reciprocal spatial position of the head, trunk, pelvic zone and lower and upper limbs of a subject in orthostasis (in sitting or inclined-static position) and their alignment in respect to a system of vertical reference i.e., from a plumb line or inside a box with vertical and horizontal references (scoliosometer).

METHODOLOGY: The patient is put into a posture ex., orthostatic. Markers can be put on some parts of the body permitting a full evaluation from the digital instrument while the patient is placed in a frontal, sagittal and horizontal position at an appropriate distance from the gauged camera.

DATA PRESENTATION: The images are then analysed using graphic software which permits evaluation and measuring of the level of alignment of the segments or corporeal planes on the three asymmetric frontal, sagittal and horizontal planes (Fig.7).

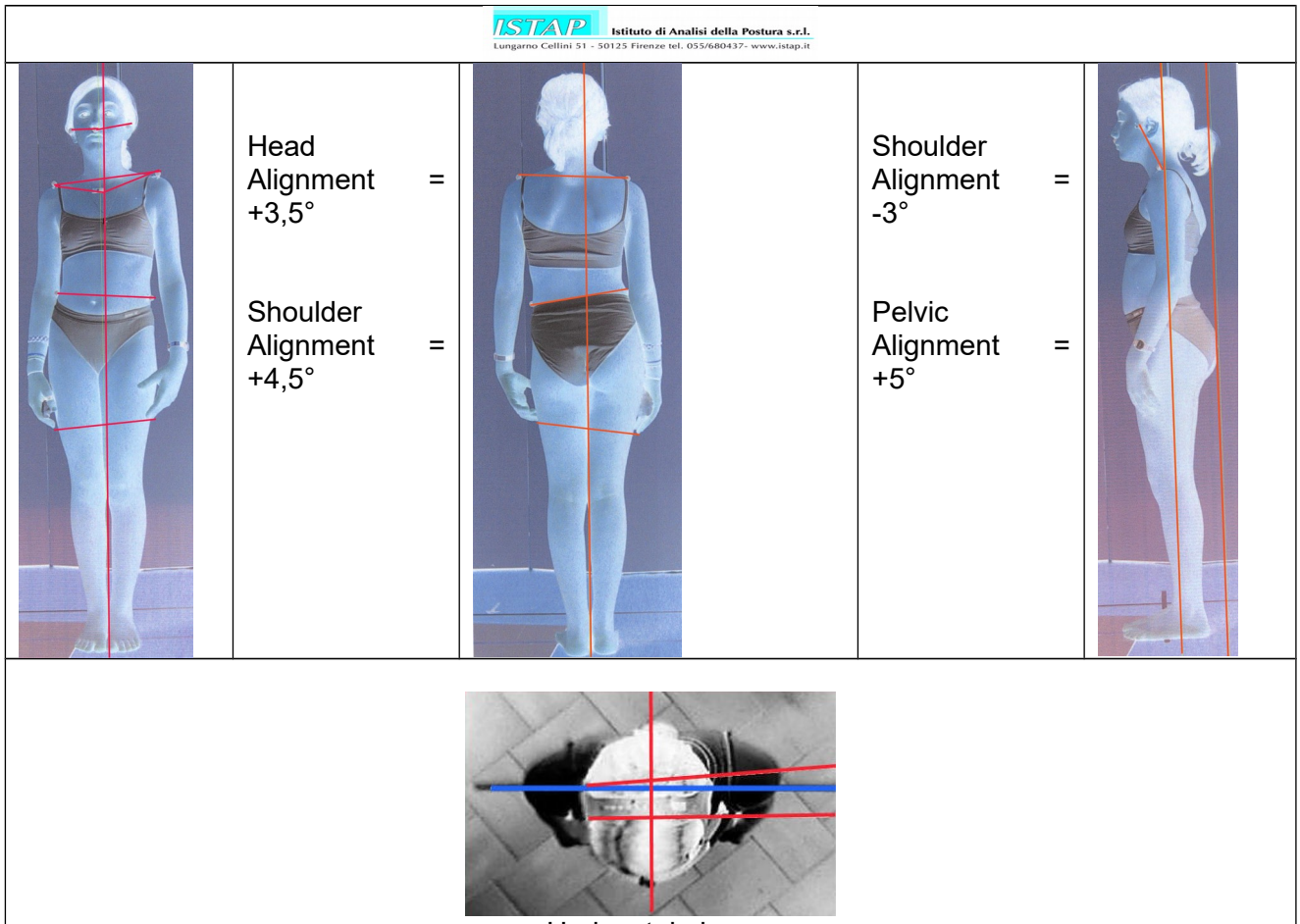


Fig.7 Somatoscope

ROM-ANALYSIS (RANGE OF MOTION): USE OF ANALYSIS INSTRUMENTS CAPABLE OF EVALUATING THE MAXIMUM ARTICULATION EXCURSUS IN DIFFERENT SPATIAL DIRECTIONS

AIM: Oblige the patients to perform movements-limits to determine the grade and the symmetry of the maximum range of some of the corporeal segments (head-neck, trunk-pelvic area, lower and upper limbs) and to evaluate the eventual presence of functional or articulation limits or blocks.

METHODOLOGY: The patient is put into the appropriate posture to carry out the programmed, angular excursus (bending, extending, rotating, abduction, adduction ….). The range of movement is controlled and measured with the application of goniometers or in clinometers precisely positioned on the parts of the body which show limited movement. Three trials are usually performed and the best evaluation chosen.

DATA PRESENTATION: Conducted in this way the analysis can be noted down in the file and thus permit a qualitative evaluation to be made of the limited functions of one or more articulations in comparison to the normal evaluation data for the age and sex and, also, to notice asymmetry of hemisomatic movements in the same individual (Fig.8).

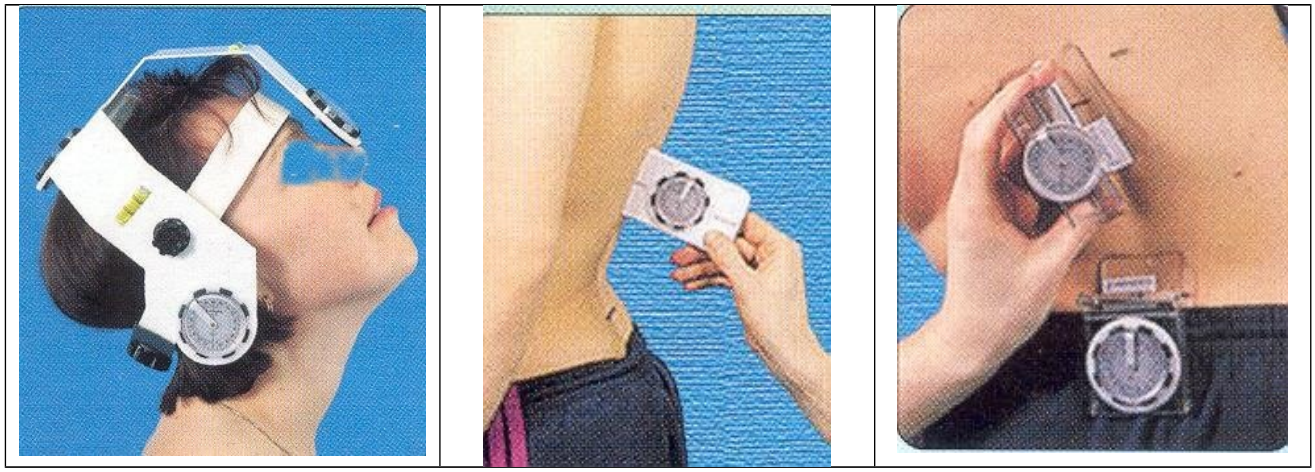


Fig.8 Rom Analysis

PODOSCOPIO: ANALYSIS OF THE PLANTAR FORM

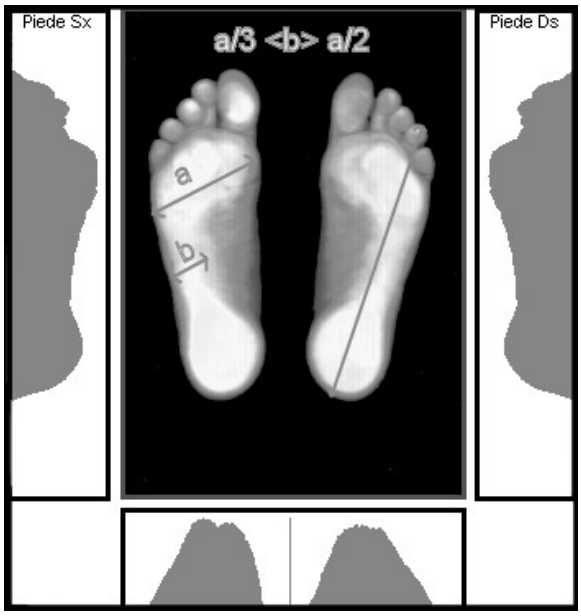
AIM: To show where the orthostatic patient's plantar supports the ground. It permits to establish the plantar conformation (ex., flat or sunken plantar) and the presence of alterations and dimorphisms in those functional areas of extra weight, valgus big toe, etc.

METHODOLOGY: The patient is standing on a glass pressure-podoscopio or scanner in an orthostatic position.

DATA PRESENTATION: The images show the various areas of pressure of the two feet on flat ground. They also permit a graphic and numeric evaluation of the plantar conformation through specific measures (flat feet, sunken arch…) and the asymmetry of the plantar support (Fig.9).

INDICATIONS: For a qualitative or near qualitative analysis of the distribution of the corporeal weight on the two feet and the pose of the plantar form.

Pressure Podoscopic footboard



Pressure Podoscopic Exam results

Fig.9 Pressurepodoscopy

PODOBAROMETRICS: ANALYSIS OF THE PLANTAR PRESSURE IN ORTHOSTATISM ON THE GROUND

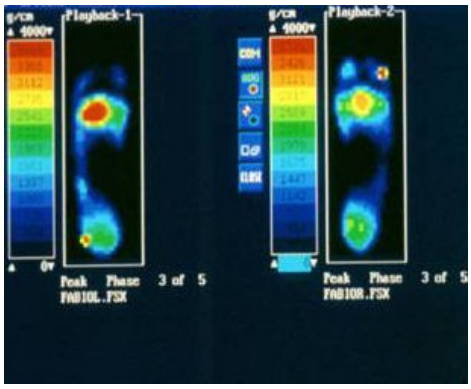
AIM: Reveal the area of the patient's plantar pressure in orthostatism on the ground. Permit to establish the presence of different alterations, for example, flat feet or sunken arch plantar and areas of extra functional weight. Furthermore, to permit the analysis of the distribution of the corporeal weight of the lower limbs on the ground from a lateral or back-front view.

METHODOLOGY: The patient is standing in the centre of a pododynamic footboard equipped with sensors (together with small electric transducers with a low, few mm, in size) pressure

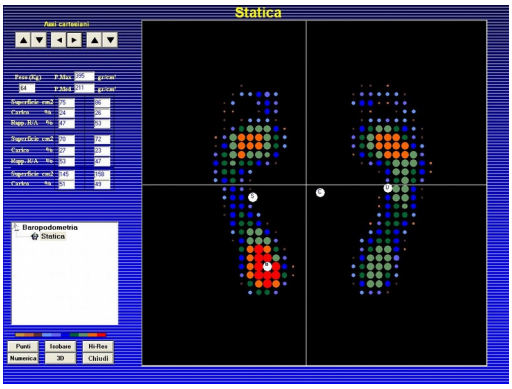
DATA PRESENTATION: The coloured and numeric graphics show the various areas of pressure of the two feet on the ground, the area the plantar form touches and the distribution of the right, left and front-back of the corporeal weight on the two feet.

INDICATIONS: For a qualitative and quantitative analysis of the distribution of the corporeal weight on the two feet and the pose of the plantar form.

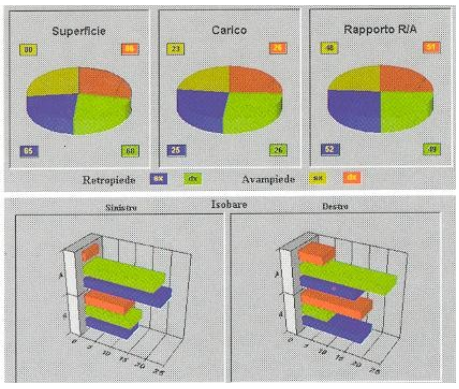
Pododynamic Footboard



Podobarometric exam result



Pressure point of the plantar



Analysis of the weight distribution on the left and the right foot

Fig.10 **Podobarometric Analysis**

2nd LEVEL INSTRUMENTAL APPROACH

SOMATOVIDEOGRAPHY: 3D ANALISYS OF THE SPATIAL ASSET OF THE BODY IN ORTHOSTATIC POSITION

AIM: Determine, with the patient in orthostatic position, the relative spatial position of the head, trunk, pelvis, and lower limbs and their alignment relative to a triplanar extracorporeal reference system orientated by a vertical plumb line and a line parallel to the horizontal plan centered on the supporting podalic polygon of the patient in the point where the centre of the mass would project itself in conditions of harmonic spatial asset .
With such an examination it is also possible to evaluate the situation of the spinal column (spatial asset, curves on the sagittal and frontal plans) in a non-invasive manner.

METHODOLOGY: Infra-red reflecting markers are applied to the subject, the position of which is measured by a gauged camera.

DATA PRESENTATION: The postural asset is presented by graphic descriptions of the frontal, sagittal, and horizontal plans accompanied by analytic explanatory comments.

INDICATIONS: All the situations in which, for preventive or diagnostic-therapeutic purposes, there is need for an objective documentation of the degree and form of the imbalance of the corporal asset compared to the inter-individual normal alignment, or for an evaluation, from case to case, of which is the most probable level from which these alterations may come from and detect possible balance or inter-individual improvement therapies.

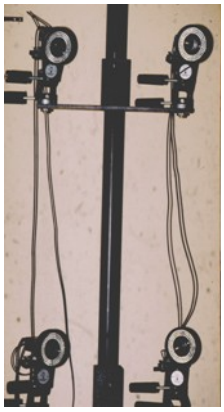
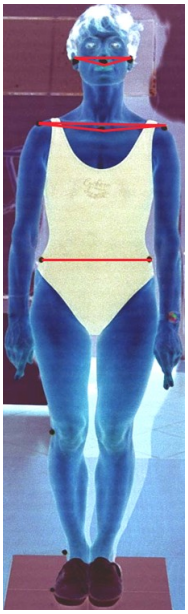
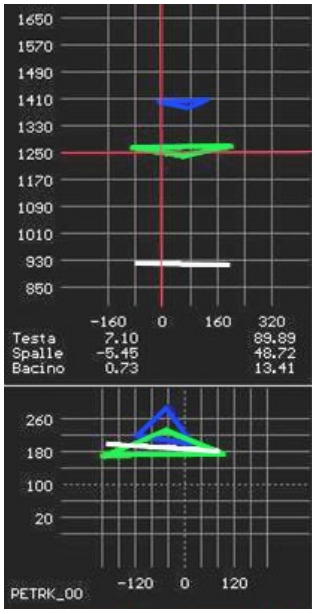
 Infrared cameras system	 Patient	=>	 Results: frontal and sagittal Exam

Fig. 11 Somatovideography

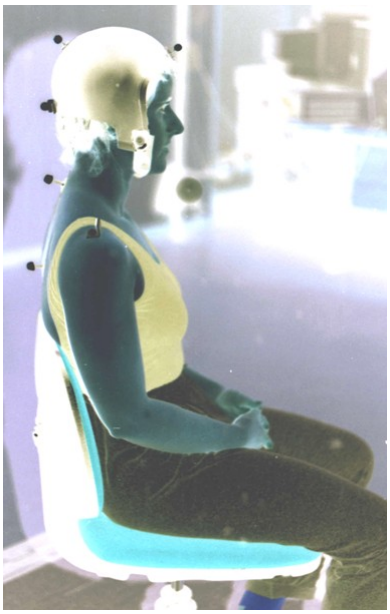
3D CERVICAL MOBILITY TEST: ANALYSIS OF THE MOVEMENT OF THE HEAD

AIM: Determine the value of the range of motion of the head in lateral flexion, rotation, flexion and extension.
It constitutes an objective evaluation of the eventual movement limitations.

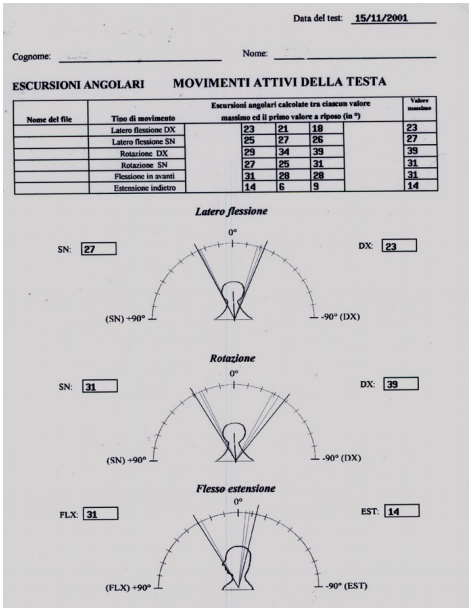
METHODOLOGY The subject, with infra-red markers applied on the head and the shoulder blade-humerus link, performs movements in front of two infra-red cameras in active mode and with eyes closed. Each movement is repeated three times and the maximum result obtained is signaled.

DATA PRESENTATION: A summarizing graphic description reports all the movements performed and signals the maximum results and eventual results outside the standards.

INDICATIONS: It's useful for all arthromyofascial pathologies because it documents the level of dysfunction and muscular dystonia and or articular alterations at the cervical level.
Together with Cervicography (the "Analysis of the movement of the cervical vertebrae" obtained from the radiographic images) it allows an evaluation of the range of motion of the neck, the degree of functionality of the single vertebral articulations and thus helps formulate an appropriate rehabilitation program.
In the medical-legal field it offers an objective documentation of the posthumous effects of a whiplash injury and of other distortions of the cervical spine.



Cervical Test



Data del test: 15/11/2001

Cognome: Nome:

ESCURSIONI ANGOLARI MOVIMENTI ATTIVI DELLA TESTA

Nome del file	Tipo di movimento	Escursioni angolari calcolate tra ciascun valore massimo ed il primo valore a riposo (in °)				Valore massimo
	Latero flessione DX	23	21	18		23
	Latero flessione SN	25	27	26		27
	Rotazione DX	29	34	39		39
	Rotazione SN	27	25	31		31
	Flessione in avanti	31	28	28		31
	Estensione indietro	14	6	9		14

Latero flessione

SN: 27 DX: 23

0° (SN) +90° -90° (DX)

Rotazione

SN: 31 DX: 39

0° (SN) +90° -90° (DX)

Flesso estensione

FLX: 31 EST: 14

0° (FLX) +90° -90° (EST)

Cervical Test Results

Fig. 12 3D Cervical Mobility Test

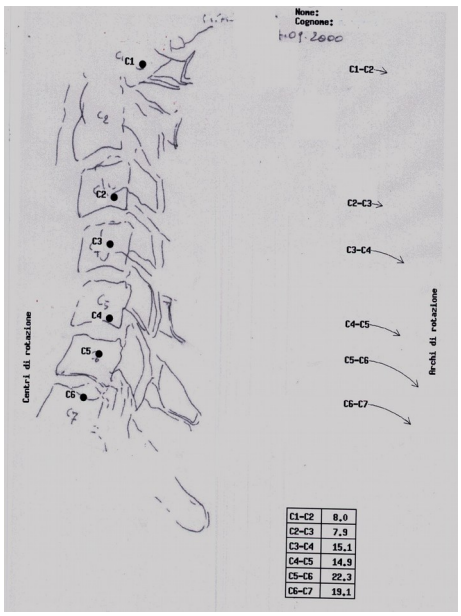
KINEMATICS OF THE CERVICAL VERTEBRAE: MOVEMENT OF THE CERVICAL VERTEBRAE ANALYSIS

AIM: Evaluate in degrees the movement that each vertebrae performs in relation to the one beneath it on the sagittal plan in the passage from hyperflexion to hyperextension. The limitations related to the radiographic images allow an evaluation of just the C2-C7 segment.

METHODOLOGY: The subject must already have had a radiography of the cervical spine in hyperflexion and hyperextension.
The appropriate elaborations and calculations are carried out on the radiographies by ISTAP using the Pennig and Dvorak methods.

DATA PRESENTATION: The graphic image shows the movements measured and two summarizing charts that signal eventual results outside the standards for both absolute movement and those relative to each cervical vertebrae (by percent).

INDICATIONS: For all cases of traumatic pathologies and not at the level of the cervical spine with suspect or clinical signs of muscular contractions, articulation impediment, ligamentous hyperlaxity or any movement alteration.
The examination allows to individuate with precision the metameric level in dysfunction.
The examination is useful in legal medicine for the documentation of the degree of biological damage and helps orientate on the possible aethiopathogenetic causes.
In the physiotherapic-orthopedic field it provides indications to orientate towards an appropriate manipulative or other kinds of physiotherapy on the involved levels.



Cervical Vertebrae

Fig.13 Kinematics of the cervical vertebrae

LUMBAR MOBILITY TEST: MOVEMENT OF THE TRUNK COMPARED TO THE PELVIS ANALYSIS

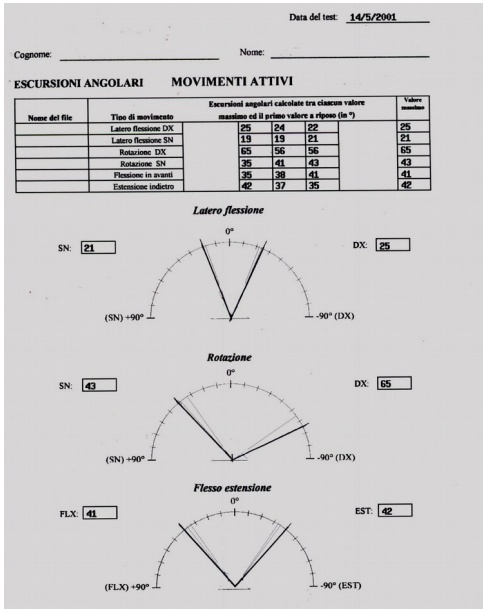
AIM: Determine the value of the maximum range of motion of the trunk (flexion and extension, lateral inclination, torsion) compared to the pelvis. It constitutes an objective evaluation of eventual limitations of movement.

METHODOLOGY: With markers applied to the trunk and the pelvis the subject performs maximum movements (compared to the pelvis) of the trunk in orthostatic position in front of two infra-red cameras in active mode with eyes closed. The movement is repeated three times and the maximum obtained is signaled.

DATA PRESENTATION: A summarizing graphic description shows the performed movements and signals the maximum results with eventual results outside the standards.

INDICATIONS: It is useful in all arthromyofascial pathologies because it reports the level of muscular dysfunction and dystonia at the dorsal-lumbar-sacral level and/or articular alterations.
Together with lumbar dynamic analysis or “Analysis of the movement of the lumbar vertebrae”, it allows a complete and exhaustive analysis of the cinematic involvement of the dorsal-lumbar-sacral regions and the degree of functionality of the single vertebrae articulations, thus helping to formulate an appropriate and personalized rehabilitation program.
In the medical-legal field it offers an objective documentation of the posthumous effects of a whiplash injury and other distortions and pathologies of the dorsal-lumbar spine and of the pelvic link.

Lumbar Test



Data del test: 14/5/2001

Cognome: Nome:

ESCURSIONI ANGOLARI MOVIMENTI ATTIVI

Nome del file	Tipo di movimento	Escursioni angolari calcolate tra ciascun valore massimo ed il primo valore a riposo (in °)				Valore massimo
	Latero flessione DX	25	24	22		25
	Latero flessione SN	19	19	21		21
	Rotazione DX	65	56	56		65
	Rotazione SN	35	41	43		43
	Flessione in avanti	35	38	41		41
	Estensione indietro	42	37	35		42

Results of Lumbar Test

Fig.14 Lumbar Mobility Test

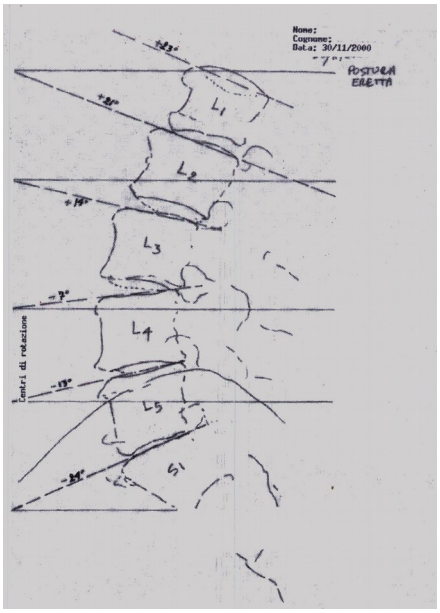
LUMBAR VERTEBRAE KINEMATICS: LUMBAR VERTEBRAE MOVEMENT ANALYSIS

AIM: Register the range of movement of the single lumbar vertebrae in maximum flexion and extension of the trunk in orthostatic position.

METHODOLOGY: The patient has a radiography (normally sagittal) at the lumbar spine level in a hyperflexed and hyperextended position. ISTAP elaborates the data.

DATA PRESENTATION: A graphic description shows the absolute movements and those relative to each lumbar vertebrae by percentage, with eventual results outside the standards.

INDICATIONS: In all traumatic pathological cases and not with suspected or proved muscular contractions, articular impediment legamentous laxity or any movement alteration at the lumbar spine level.
The examination allows to individuate with extreme precision the dysfunctional metameric level. The examination is useful in legal medicine to document the degree of biological damage and help determine the possible aethiopathogenetic causes.
In the physiotherapic- orthopedic field it provides precious indications to help determine an appropriate manipulative or other kinds of physiotherapy on the involved levels.



Vertebrae Lumbar

Fig.15 Lumbar Vertebrae Kinematics

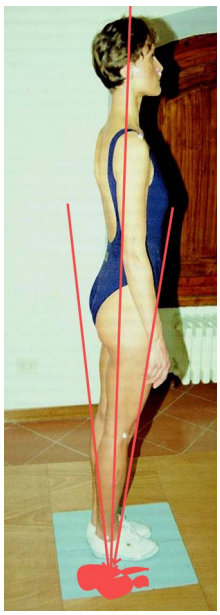
POSTUROGRAPHY, STABILOMETRY: ANALYSIS OF THE ALLOCATION OF THE WEIGHT TO THE GROUND AND OF THE OSCILLATORY CONTROL OF THE BODY IN ORTHOSTATIC POSITION

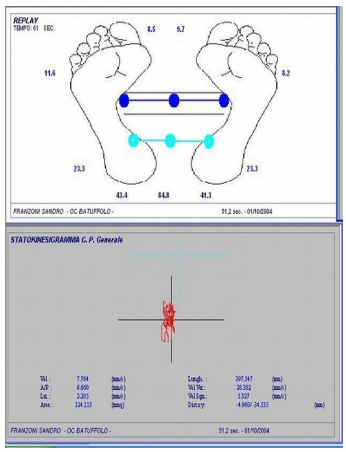
AIM: Highlight the degree and orientation of the strength externalized from the body to the ground during oscillatory activity for the control of balance in the static erect position.
It allows an analysis, through a strength pad, the distribution of body weight compared to the supporting feet polygon, the characteristics of the oscillations of the body's centre of gravity compared to the ground and it allows to obtain information on the functionality of various sub-systems that help keep the body in orthostatic balance (neuro-muscular, visual and vestibular apparatus).

METHODOLOGY: The patient, standing, is placed in the middle of a strength pad to record the characteristic parameters of its oscillatory control. The two basic tests are performed with the subject having eyes open the first time and closed the second for the same time (approximately 45 seconds)

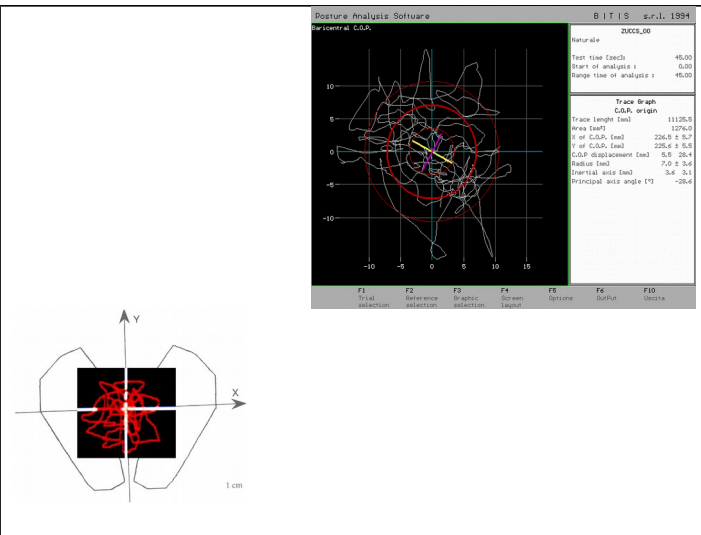
DATA PRESENTATION: Numerous graphics and information are obtained, of which:
A) The coordinates of the ground projection of the centre of gravity compared to the supporting polygon (distribution of anterior/posterior and lateral weight)
B) The area and length of oscillation (respectively related to the precision of the postural system and to the muscular fatigue)
C) The presence of lateral, anterior or posterior drifts of the oscillations
D) The speed and frequency of the oscillations

INDICATIONS: In all pathologies with clinical descriptions of the pain-dysfunctional type at one or more levels of the postural kinetic chain (from the cranium-mandible system to the feet) with or without balance disturbances in which the level primarily affected by the noxa must be sought.





Posturography, Stabilometry



Results posturographic and stabilometric Exam

Fig.16 Posturography, Stabilometry

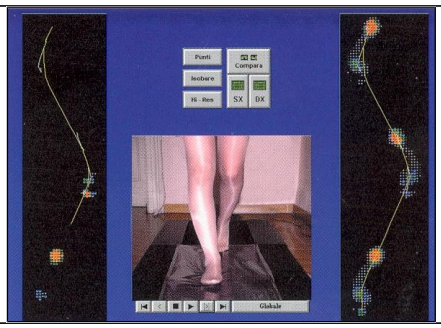
KINETIC ANALYSIS OF THE FOOTSTEP: ANALYSIS OF THE GROUND FORCES OF THE FOOT IN GAIT

AIM: Highlight the supporting areas, the degree and orientation of the externalized strengths from the foot to the ground in gait.

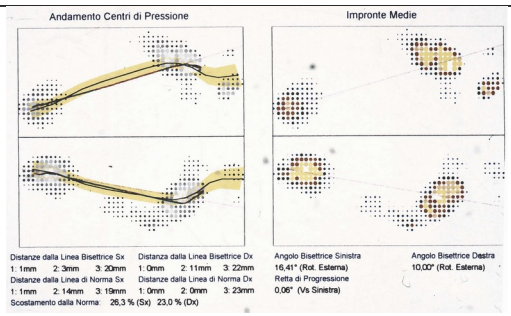
METHODOLOGY: The patient walks on a strength pad or on sensor pads able to register the expressed strength to the ground and spatial variations of the supporting point during such movements.

DATA PRESENTATION: On the podobarometric pad it is possible to highlight the direction of the variation of the centre of pressure to the ground during the walking movement (angle of footstep), the temporal trend and the entity of the vertical strength during the whole step. On the strength pads it is possible to analyze the results of the vector strengths: not only vertical but also medium-lateral and anterior-posterior vectors.

INDICATIONS: For a quantitative and qualitative analysis of the performance of the ground strength involved in gait and for the design of eventual plantar prosthesis.



Podobarometric Analysis of footstep



Area and movements of centre of pressure

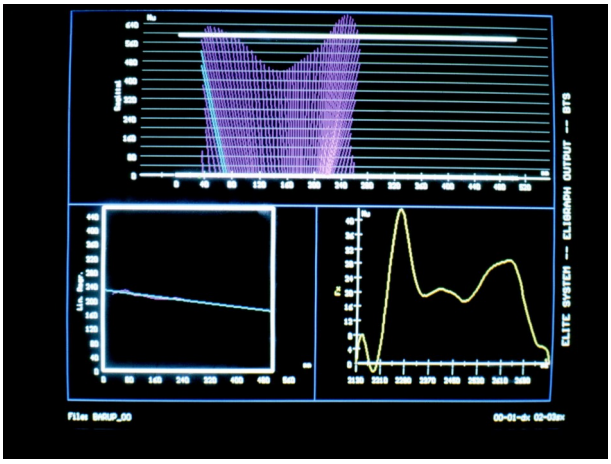
	
Analysis of footstep on strength pad	Vertical and medium lateral forces. Angle of footstep

Fig.17 Kinetic Analysis of the footstep

KINEMATIC ANALYSIS OF THE FOOTSTEP: OPTICAL ANALYSIS OF THE GROUND FORCES OF THE LOWER LIMBS IN GAIT

AIM: Highlight the spatial movement of the lower limbs (foot, leg, thigh) and of the pelvis in gait.
It allows to define the presence of alterations and/ or kinematic asymmetries of both lower limbs

METHODOLOGY: The patient is recorded on digital or infra-red cameras while walking (in this case feet, legs pelvis are checked by reflective markers) to register the movements qualitatively in 2D in the first case and quantitatively in 3D in the second (angles and spatial positions).

DATA PRESENTATION: the images and graphic descriptions highlight the direction and various types of movement performed by both lower limbs during all phases of the footstep.

INDICATIONS: For a quantitative and qualitative analysis of the performance of the ground forces while walking.

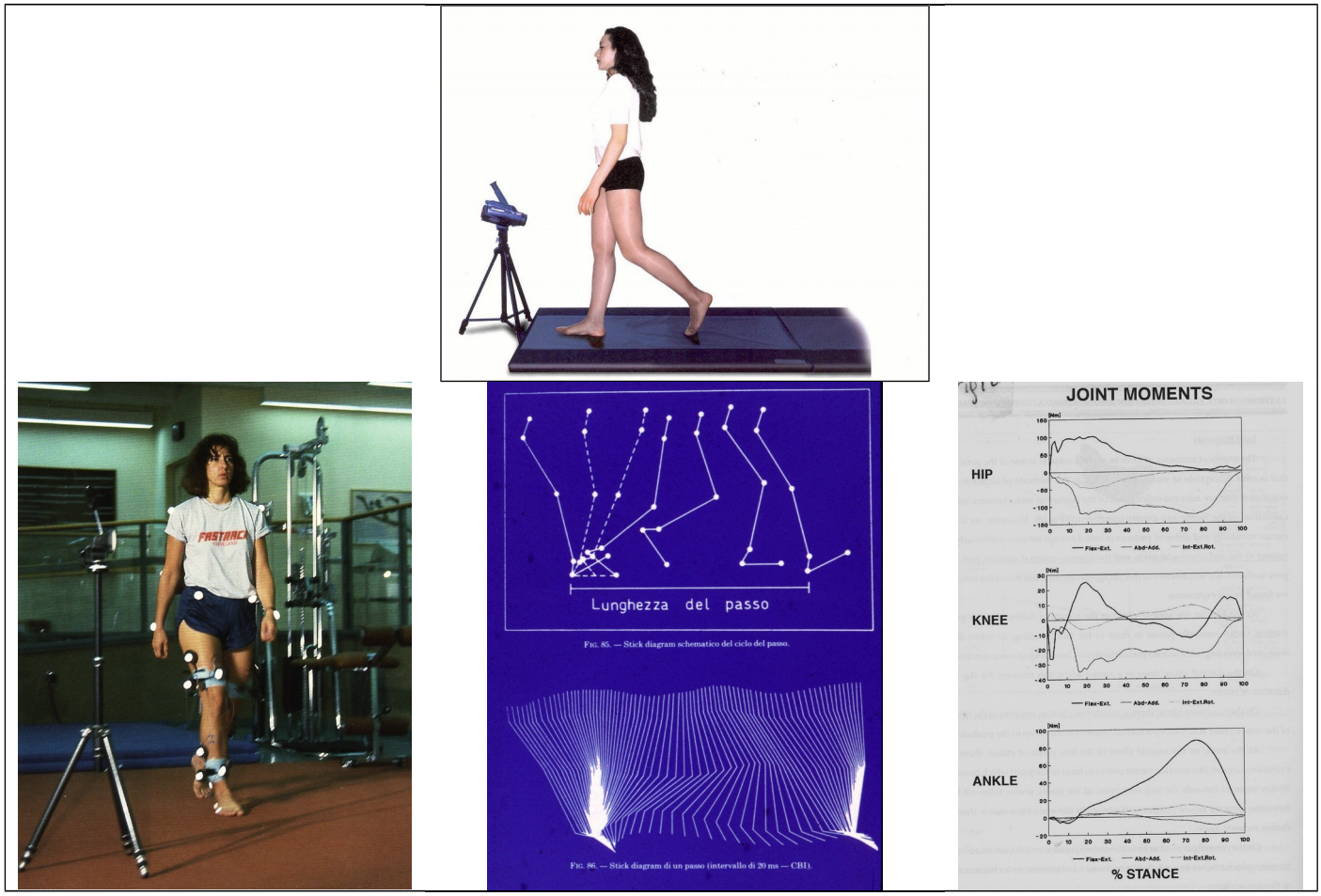


Fig.18 Kinematic Analysis of the footstep

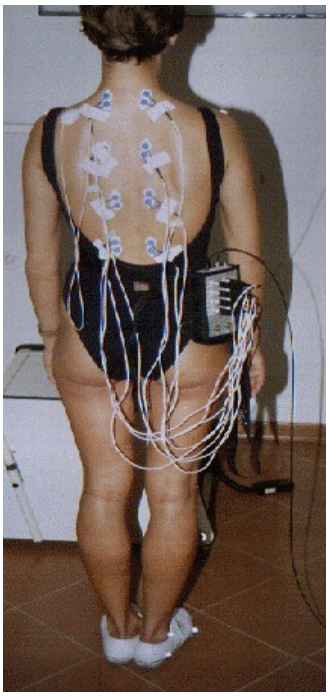
PARAVERTEBRAL ELECTROMIOGRAPHY: DOCUMENTATION OF THE ELECTRICAL PERFORMANCE OF THE PARAVERTEBRAL MUSCLES WHEN RESTING AND WHEN STIMULATED

AIM: Gain knowledge of the degree of symmetrical/asymmetrical work performed by the postural para-vertebral muscles in static (in orthostatic position) or dynamic condition.

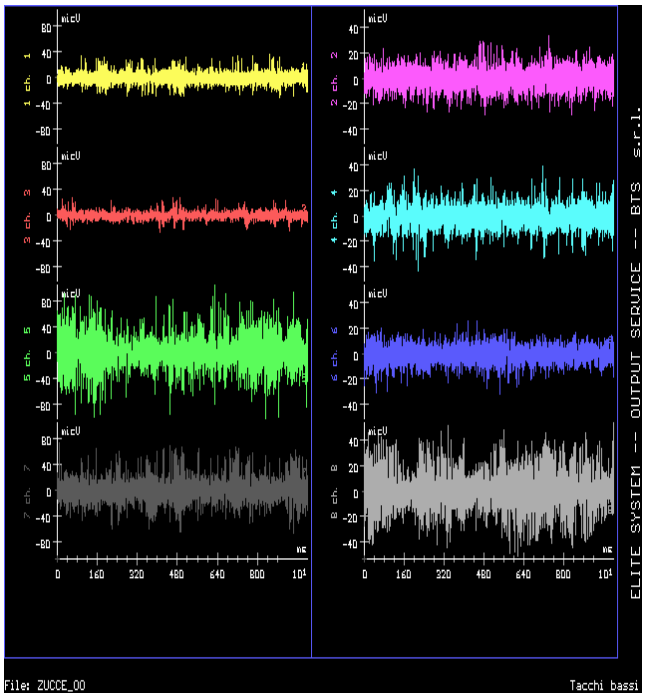
METHODOLOGY*:* Surface bipolar electrodes are applied in silver chloride to the para-vertebral regions of the subject in the C3, D3, D10, L3 areas for the electromyographic recording in static (orthostatis) and dynamic (isometric anterior flexion of the trunk carrying weight) conditions.

DATA PRESENTATION: The graphic descriptions show the degree of asymmetry/symmetry between the left and right para-vertebral muscles in static and dynamic conditions.

INDICATIONS: All cases of pain-dysfunctional syndromes at the spine level; and for the study of the dysfunctions of the spinal cord (scoliotic trends, scoliosis, alterations of the curves on the sagittal plan) also correlated with the dysmetria of the lower limbs and feet and occlusal alterations.



Electromiography



Results of Electromyography Exam

Fig.19 Paravertebral Electromyography

MAIN INSTRUMENTAL EXAMS IN PRIMARY CHECK_UP ISTAP

Materials and Method. In the Florence Centre of Posture Analysis and at the University of Chieti a type of integrated multifactor clinical diagnostic protocol ([1],[2], [13], [14], [15], [16], [17]) has been applied. This makes use of a computerized clinical anamnestic protocol (Software ISTAP Ridi R., Ridi L., Puglisi A.), of 2D digital optic apparatus and 3D optic-electronic instruments for kinematical examinations of the spatial corporeal asset, ground reaction forces platform, podobarometric and podoscopic system in order to analyse the static and dynamic forces while walking, thanks to the specific software programme. The software is able to evaluate the level of postural alteration in patients using a score system.

The postural aspects analysed are:

- Orthostatic position of a number of principle planes and points: the cephalic level, the level of the stern belt–humeral shoulder blade and pelvic belt on subjects positioned with parallel feet in a 3D extra-corporeal system plumb line orientated in accordance with the model of the Ridi-Rossi (somatographic analysis) protocol ([12],[13], [14])
- Morphology of the support given by the arch of the foot in subjects with orthostatic problems and in parallel foot positioning (podoscopic analysis);
- Analysis of the distribution of the ground reaction forces caused by the arch of the foot in orthostatic position (podobarometric analysis);
- Distribution and control of ground reaction forces and of the average position of the centre of pressure given by mechanisms controlling orthostatic balance in subjects whose feet were positioned at an angle of 30% (stabilometric analysis);
- Ground reaction forces expressed by the foot while walking (gait analysis).

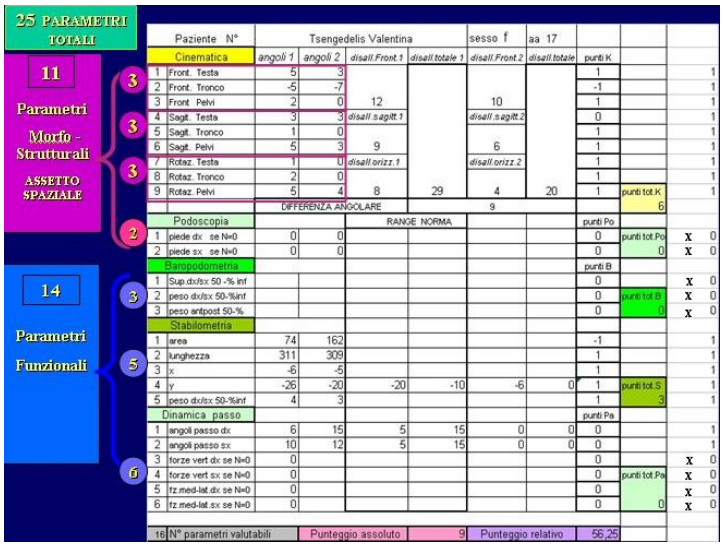
The data relative to instrumental evaluation and to the global posture score are registered in a file on the basis of 25 parameters(Fig.20).

More specifically, the 25 posture parameters taken into consideration were:

- 9 kinematical postures of which 3 right-angles, non-aligned static positions on the frontal, sagittal and horizontal plane of each of the cephalic, stern-shoulder-humeral and pelvic plane. To carry out these exams 2D digital photographic instruments were used (Sony, Philips To-Ucam). Such apparatus was appropriately tested on a three plane spatial axis and assisted by ISTAP software in the development of 3D infra-red optic-electronic apparatus, (Microsystems Avaro, M.) with analysis software Ridi R.-Bassi L. (Figg.21-22).
- 2 parameters analysing the right and left arch of the foot in orthostatism. This examination was carried out by using an appropriately modified Mustek A3 scanner, run on ISTAP software.
- 3 podobarometric parameters for the analysis of orthostatism and of feet in parallel position to the hip-joint. One parameter examines the surfaces of the feet while the second examines the distribution of corporeal weight on the two lower limbs (rx-lx, anterior and posterior side). A footboard with matrix sensors (Physical Support) was used for this examination.
- 5 parameters concerned the stability in orthostatic position, with feet unaligned at 30° on a floorboard silhouette. 2 parameters were relative to the spacing and to the length of movements; 2 to the x and y coordinates on ground pressure; 1 to the distribution of corporeal weight on the two lower limbs in rx-lx lateral axis with unaligned feet.

  In order to carry out this exam, a postural stabilometric footboard with three force-transducers (anterior, medium and lateral) made by Correcta DL Medica, on the basis of international construction, sensibility and testing norms, were used for each single foot.
- 6 parameters on the movements when walking (gait analysis), of which 2 call into play the vertical ground forces of the foot, 2 medium-lateral forces and the final 2 a comparison between the angle (angle of the step) i.e. the line of regression, and the touch point of both feet on the ground and the manner of walking. AMTI resistant ground platform transducers were used for this examination.

In evaluating data we referred to international literature ([1],[2],[3],[4],[5],[6],[7],[8],[9],[10],[11]).



25 PARAMETRI TOTALI											
		Paziente N°	Tsengedelis Valentina				sesso f	aa 17			
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11 Parametri Morfo - Strutturali ASSETTO SPAZIALE	3	1 Front. Testa	5	3					1		1
		2 Front. Tronco	-5	-7					-1		1
		3 Front. Pelvi	2	0	12		10		1		1
	3	4 Sagit. Testa	3	3	disall.s.agitt.1		disall.s.agitt.2		0		1
		5 Sagit. Tronco	1	0					1		1
		6 Sagit. Pelvi	5	3	9		6		1		1
	3	7 Rotaz. Testa	1	0	disall.orizz.1		disall.orizz.2		1		1
		8 Rotaz. Tronco	2	0					1		1
		9 Rotaz. Pelvi	5	4	8	29	4	20	1	punti tot K	1
			DIFFERENZA ANGOLARE				9			6	
		Podoscopia			RANGE NORMA				punti Po		
	2	1 piede dx se N=0	0	0					0	punti tot Po	x 0
		2 piede sx se N=0	0	0					0	0	x 0
14 Parametri Funzionali		Baropodometria							punti B		
	3	1 Sup.dx/sx 50 -% inf							0		x 0
		2 peso dx/sx 50-%inf							0	punti tot B	x 0
		3 peso antpost 50-%							0	0	x 0
		Stabilometria									
		1 area	74	162					-1		1
	5	2 lunghezza	311	309					1		1
		3 x	-6	-5					1		1
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		1 angoli passo dx	6	15	5	15	0	0	0		1
		2 angoli passo sx	10	12	5	15	0	0	0		1
		3 forze vert dx se N=0	0						0		x 0
	6	4 forze vert sx se N=0	0						0	punti tot Pa	x 0
		5 fz.med-lat.dx se N=0	0						0		x 0
		6 fz.med-lat.sx se N=0	0						0	0	x 0
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Fig.20

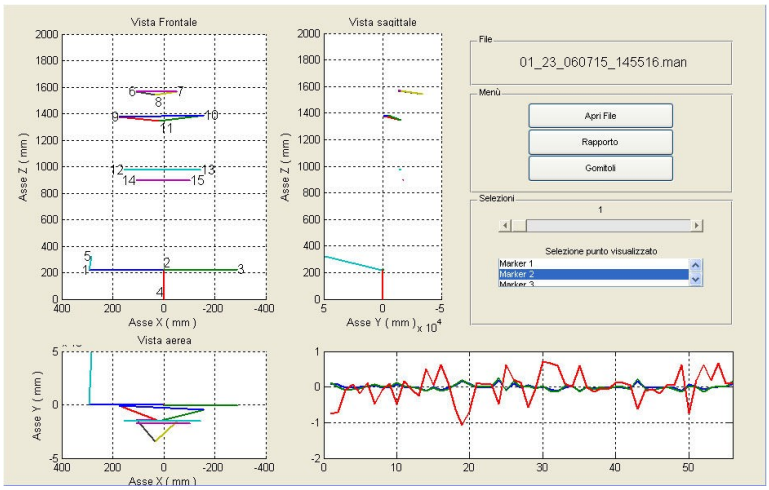


Fig.21

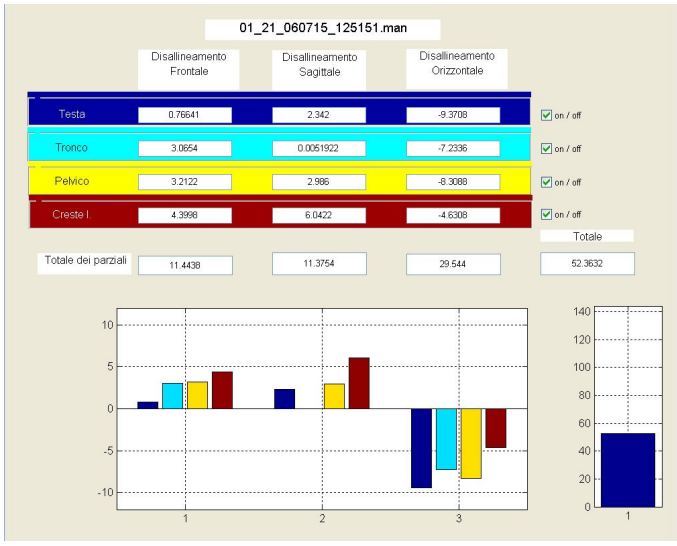


Fig.22

Software *SOMATOGRAPHIC ANALYSIS 3D* (Ridi R.-Bassi L).

In this first phase evaluation the morphological-structural parameters and functional parameters are considered to the subject in normal conditions.
In a later phase, tests of different stimulations of the sub-systems are carried out by means of changes of sensorial inputs (visual deprivation, de-reprogramming with soft thickness, proprioceptive information at various levels, functional activations) for the purpose of evaluating their state of function or dysfunction
(TREND TESTS).
This is realized by recording the global body answers in terms of spatial asset, static and dynamic plantar ground reaction forces and orthostatic stabilometric control.
According to the answer (negative,
positive or indifferent), referring to the habitual parameters at onset of which the range oscillation is preliminarily calculated, essential for the determination of the importance of the answers to the trend test, the software is able to give a grade of dysfunction to the various tested areas.
On the basis of such instrumental research aimed for a specific analysis of every subject regarding the functionality of the patient's sub-systems, it is possible to classify the answers in four main categories.

- PIC (postural imbalance category) is the category of patients who have registered dysfunctions in postural areas outside of the stomatognathic system
- SIC (stomatognathic imbalance category) is the category of patients who have registered dysfunctions predominantly dependant on the stomatognathic system
- PSIC (postural and stomatognathic imbalance category) is the category of patients who have registered dysfunctions on the stomatognathic sub-system and others
- LIRC (low instrumental response category) is the category of patients who have not registered any relevant answers in the various areas and thus may be subjects of internal medicine or neuropsychiatric interest

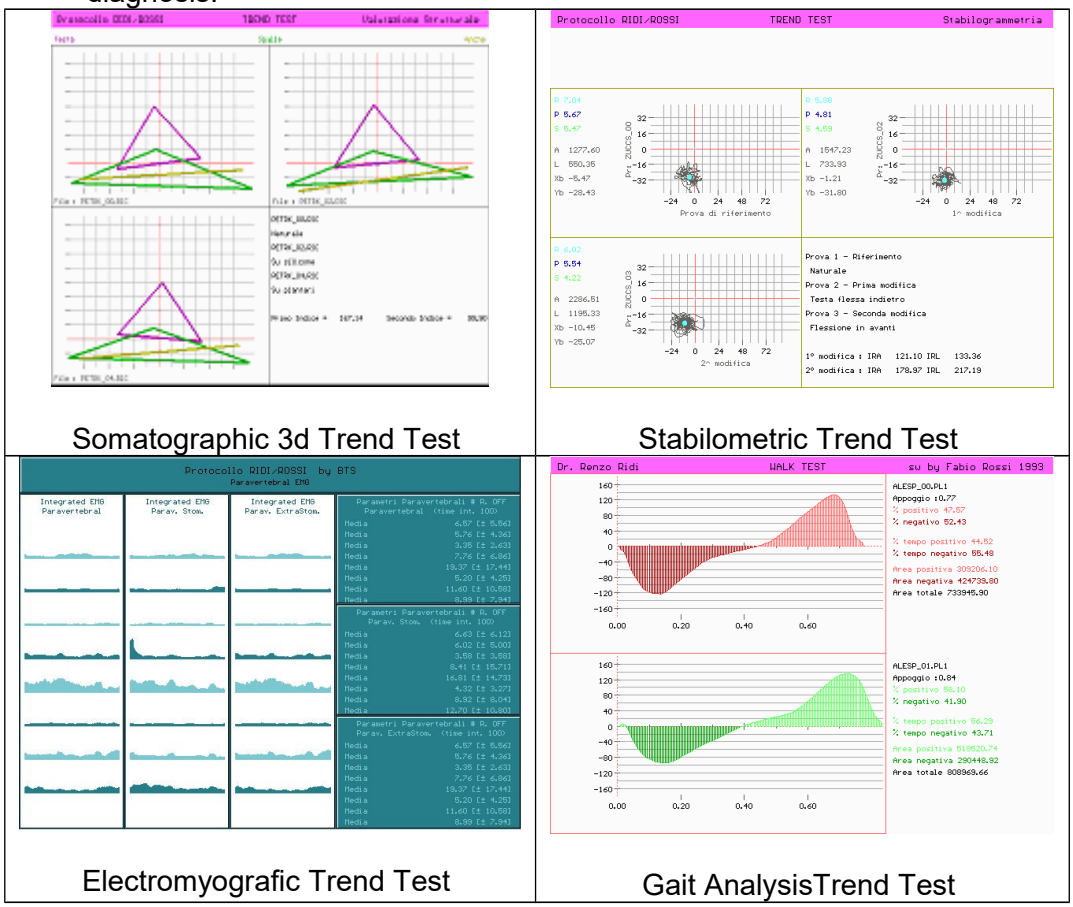
TREND TEST: EVALUATION OF THE FUNCTIONAL POSTURAL ANSWERS INDUCED BY (sensorial input) MODIFICATIONS APPLICATED TO THE SUB-SYSTEMS

AIM: The use of programmed sensorial-afferent stimulations at various levels (de-programming or re-programming inputs or dynamic activation) allows answers (outputs) to be obtained that can be registered in various functional graphics as improving, worsening or indifferent compared to the habitual basic conditions previously memorized heeding the range of fluctuation of the standard (through retests). In relation to the kind of answer obtained and to the reference basis it is possible to have information regarding the functionality of the primary systems and sub-systems that cooperate to the realization of the postural homeostasis (visual, vestibular, central nervous proprio-exteroreceptors of the kinetic chain such as the stomatognathic, cervical-thoracic, lumbar-pelvic and podalic sub-system).

METHODOLOGY: The subjects are put in the same conditions of the previous tests but in new sensorial stimulation modes (stomatognathic deprogramming with soft occlusal thickness plantar de-programming with soft support, plantar re-programming with soles, dynamic cervical and lumbar activation with bent head or trunk etc).

DATA PRESENTATION: The comparison between the first and the trial tests under the stabilometric and somatographic are shown with the relative indications of variation.
The variations under the electromyiographic vertebral parameters or kinetic parameters of the footstep are reserved to cases of more uncertain diagnosis or difficulty.

INDICATIONS: All arthromyofascial pathologies and postural imbalances of difficult diagnosis.



Somatographic 3d Trend Test | Stabilometric Trend Test

Electromyografic Trend Test | Gait AnalysisTrend Test

Fig.23 Trend Test

ADVANCED SPECIALISTIC INSTRUMENTAL PROCEDURES

After this functional multidiscipline postural evaluation and according to diagnostic responses , we can examine in more detail the dysfunctional subsystems.
In regard to the cranium-mandible subsystem, we can employ the electrognatographic instrumentation that is kinesiography and electromyography for an evaluation of the mandible movements, muscular electrical activity and arthrosonography for the registration of the sounds of the temporal-mandible joint.

MANDIBULAR KINESIOGRAPHY (MKG): ANALYSIS OF MANDIBULAR MOVEMENTS

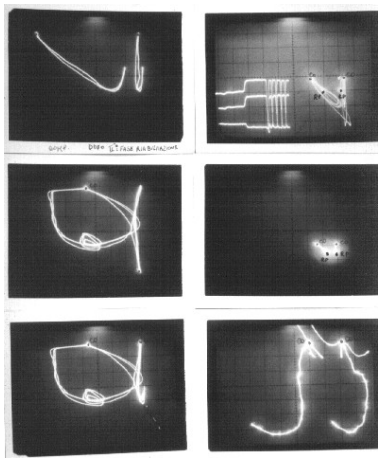
AIM: Evaluate the functionality of the artromyofascial components of the stomatognathic system and the regularity of the occlusal relations of the dental arches in normal conditions or after muscular re-programming by means of the application of TENS (transcutaneous electrical neural stimulation) for the de-programming and relaxation of those muscles supplied by V and VII nerve the masticating muscles).

METHODOLOGY: A small magnetic transmitter is applied in the lower incisive medium mandible. This magnet will move consensually to the movements made by the jaw and its movement is recorded thanks to a transductor-loom applied firmly to the cranium. The subject performs minimum/maximum opening of the jaw, small closing movements of the jaw starting in a resting position slightly apart from the superior arch, swallowing movements, frontal and lateral grinding movements.

DATA PRESENTATION: Graphic descriptions are shown (generally six) in which important parameters are recorded for the purpose of a functional evaluation of the stomatognatic system as are the degree, the spatial performance and speed of trajectories of the opening/closing of the mouth, trajectories of the closing of the dental arches, the type of deglutition. It is possible to record the aforementioned test again after the application of electro-stimulation and to evaluate the differences and possible improvements.

INDICATIONS: It is indicated for the diagnostic and therapeutic programming of all pain - dysfunctional pathologies of the stomatognathic system, specifically of the templar-mandible articulation dysfunction, in all cases of pathogenic occlusions, cranium-mandible dysfunctions, headaches, cervical-facial pain, TMJ pain, limited opening, ear congestion, dizziness, ringing in ears, dysphagia, postural problems, bruxing/clenching, pathologies where there is a suspected presence of muscular-tense components or of imbalance starting in the mandible-cranium system. It also has indications for the planning and control of orthodontic therapies, as well as in legal medicine for the evaluation of the results of traumas (whiplash for example, in the stomatognathic field).

Mandible Kinesiography



Results of Mandible Kinesiography Exam

Fig.24 Mandibular Kinesiography (MKG)

MANDIBLE-CRANIUM-CERVICAL ELECTROMIOGRAPHY: ANALYSIS OF REST ACTIVITY AND IN FUNCTION OF THE MASTICATING AND CERVICAL MUSCLES

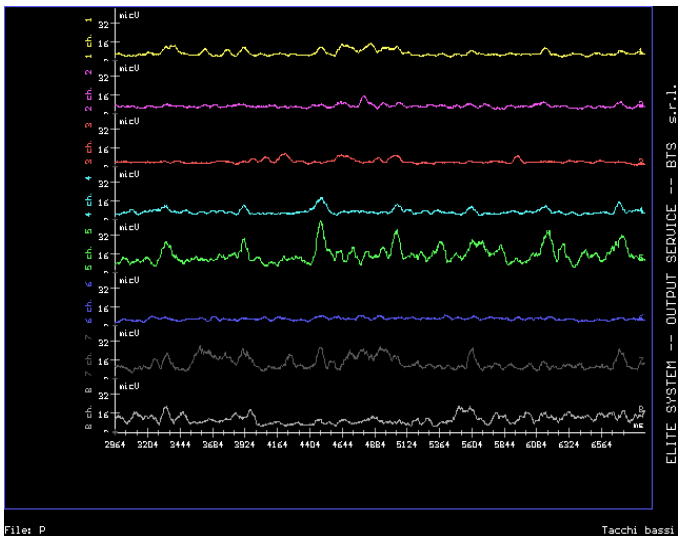
AIM: Evaluate the level of functional equilibrium and imbalance present at the level of the stomatognathic or cervical systems registering the masticating muscular activity and the cervical activity when resting (grade of tension) and when active (ex., the closure of the dental arch in a habitual way or de-programmed with Tens) comparing them with normal reference parameters.

METHODOLOGY: Surface bipolar electrodes in CL-Ag are applied onto the patient usually in temporary frontal, masseter, sternocleidomastoid, left and right under-mandible areas and by means of electromyography the activity of these muscles at rest can be shown. Following this the patient is asked to carry out some mandible movements (ex., closing teeth in a normal occlusion or de-programmed with soft thickness, swallowing, etc). The muscular activity of the elevating mandible muscles in functional activity is then registered. These tests allow for further confronted after the application of electro-stimulation on the masticating muscles with Tens.

DATA PRESENTATION: Three tests are usually proposed: one which relates to the values of muscles at rest with reference to the normal inter-individual range; a second registers the maximum values and the functional symmetry of the right and left elevating mandible muscles (temporal front and masseter) in habitual closure and/or deprogrammed; the third relates to the grade of synchronization (recruitment time) of the these same muscles in occlusion (Fig.25)

INDICATIONS: In all the algic-dyfunctional pathologies, both primitive and secondary, in which the myofascial components of the stomatognathic or cervical systems are involved as the result or not of traumas.

Electromyography



Results of Mandible-Cranium Cervical Electromyography Exam

Fig.25 Mandible-Cranium Cervical Electromyography

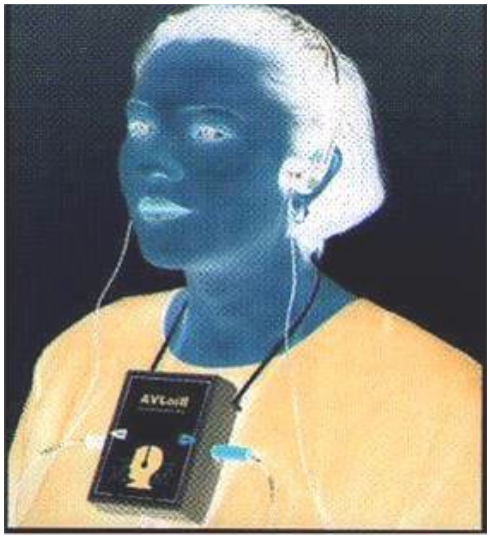
ARTHROSONOGRAPHY OF THE TEMPORAL-MANDIBLE JOINT:
REGISTRATION OF THE SOUNDS OF THE TEMPORAL MANDIBLE JOINT IN THE OPENING/CLOSING MOVEMENTS OF THE MOUTH

AIM: Register and analyse graphically the sounds that are present at the left and right temporal-mandible articulation during the movement of opening and closing the mouth.

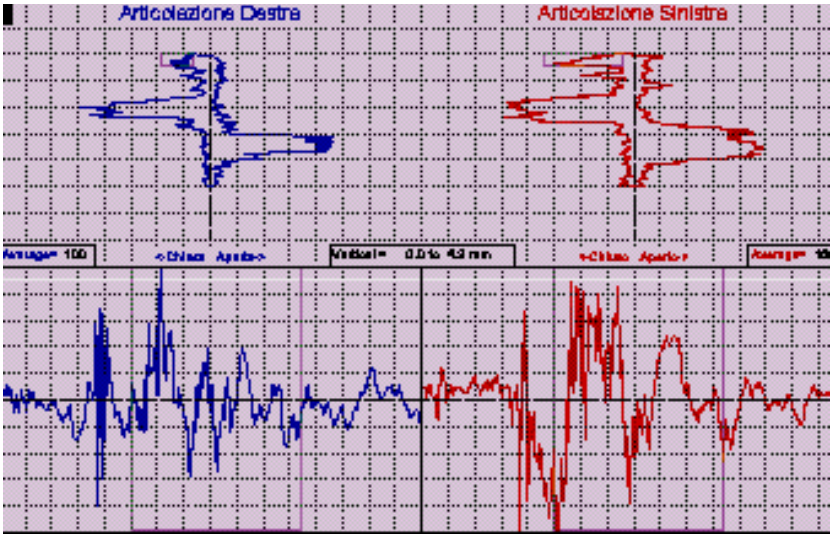
METHODOLOGY: Two earphones, equipped with electrophonendoscopes that are connected to the appropriate registering machine, are attached to the anterior areas of the two ears (tragal region) relating to the mandible articulation poles. The patient is made to carry out continuous movements of opening and closing of the mouth in coordination and synchronised to the movements of a guide-dot that is moving on the screen and acts as a metronome.

DATA PRESENTATION: Every sound that may be heard during the opening and closing phase is registered on the vertical lines as horizontal deviations of proportional length to the entity of the sound (Fig. 26).
Furthermore, it is possible to analyse the sound in its frequency traits.

INDICATIONS: In all the cases of disorders of the temporal-mandible articulations where an objective documentation of the problematic of sound is often correlated to the phenomenon of disk-condyle incoordination or arthrosis.



Sonography



Results of Arthrosonography Exam

Fig.26 Arthrosonography

MANAGEMENT OF THE MANDIBLE-CRANIC-POSTURAL MALFUNCTION DIAGNOSTICS ON THE BASIS OF THE INTEGRATED MULTIFACTOR ANALYSIS PROTOCOL

The complete exam of all these parameters evinced from the instrumental examinations at various levels, appropriately integrated with the evaluation of the clinical data, gives the doctor a valuable support for the orientation of the type, the position and the kind of pathogen noxa in play in the mandible-cranium postural imbalance.
The patients taking part in this exam can, in this way, be classified into four categories of instrumental results:

° 1) Class P.I.C. (Postural Imbalance Category) where the instrumental responses orientate the diagnosis of the presence of imbalances of the extra-stomatographic type.

° 2) Class S.I.C. (Stomatognathic Imbalance Category) where the instrumental responses correlate to factors of imbalances in the stomatognathic field.

° 3) Class P.S.I.C. (Postural/Stomatognathic Imbalance Category) where many instrumental responses coexist to factors of postural imbalances as well as responses referring to stomatognathic factors.

° 4) Class L.I.R.C. (Low Instrumental Response Category) where no significant responses exist at any level excluding in this way the presence of imbalances of the biomechanical type at the base of the dysfunction and indicating probable problems of the metabolic or neuropsychological type).

In a survey of 300 dysfunctional patients ATM carried out with the ISTAP protocol of Prof. Renzo Ridi, Prof. Raoul Saggini in collaboration with the Università degli Studi G. D'Annunzio in Chieti, Italy (Acts of the National Congress of Medicine in Sport, S.I.M.F.E.R International Society of Myochemistry on 2nd-5th July 1995 in Pescara, Italy, 14th International Congress A.I.O.P. on 11th November 1995 in Bologna, Italy) the following statistical classifications were attained:

20%	subjects	Class 1 P.I.C.
15%	subjects	Class 2 S.I.C.
60%	subjects	Class 3 P.S.I.C.
5%	subjects	Class 4 L.I.R.C.

THERAPEUTIC MANAGEMENT OF THE MANDIBLE-CRANIUM-POSTURAL DYSFUNCTION ACCORDING TO A DIAGNOSTIC SYSTEM

A SINGLE OR MULTIDICIPLINE APPROACH ACCORDING TO THE DIAGNOSTIC SCHEME (4th CLASS)

THE INTEGRATED FUNCTIONAL BIO- PROGRESSIVE SYSTEM

The criteria of the choice and therapy methods must be decided bearing in mind the data derived from a sound clinical/instrumental diagnostic protocol and by differentiating and personalising each case in function of the different characteristics with which the pathology is clinically extrinsic.
This means that patients with cranium-mandible-postural dysfunctions, those, for example belonging to the S.I.C. Class, will be treated with only one therapy at the stomatognathic level, while patients belonging to the P.S.I.C. Class will be treated with both stomatognathic and extra-stomatognathic therapies, precisely at the postural areas which result primarily involved with the pathology itself.
Such therapeutic methods involve the organised work of a multi-disciplined medical team who together cure the same patient over a long period of time both under an odontological profile as under a physiotherapic-rehabilitation one, each time adjusting the therapeutic resolutions according to the patient's progress.
We have defined this procedure A.F.I.B. (Functional, Integrated and Bio-progressive System).

CLINICAL-INSTRUMENTAL CONTROL PROGRAMMED OVER TIME WITH EVALUATIONS OF THE PHASES OF RE-EQUILIBRIUM, OR THE TREND OF THE CLINICAL AND INSTRUMENTAL IMPROVEMENT

Thanks to the integrated multifactor clinical-instrumental evaluation, previously described, through which a diagnostic-differential screening of the mandible-cranium-postural pathology is obtained, it is not only possible to establish a rational therapeutic program that is appropriate and integrated, but which, at any time, can monitor the functional progress of the patient by comparing data and starting parameters with data and parameters relative to the actual situation.

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