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Comparative "Sistemic" Phylo-Onto-Morfogenesis of Hand and Foot with replication in dismorfic and meta-traumatic pathology and relative surgical implications (i.e., Coxa Manus Surgery versus Sistemic Foot Surgery)

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Summary

In this study, we discuss the systemic correlations of the damaged hand and foot in anatomy - also known as dysmorphia (congenital, degenerative or post-traumatic pathologies) considered in the perspective of Goethe's Morphogenetics and of the Regression Principle (of Systemic-Cybernetic derivation**)**, according to "*in biological structures, the anatomical insult tends to evoke the Phylo-Onto-Morphogenesis in an adaptive way*".

The study also exposes the derived clinical-diagnostic and surgical applications. So, in the Hand, anatomical damage tends to arise in Adaptive Carpus, with instability, up to the Carpal Collapse; while in the Foot it arises with the various dysmorphic clinical manifestations of the Triangular Forefoot (TF) and/or Splay Foot (SF). In clinical practice, since such pathologies are the consequence of "adaptative" phenomena, it follows that the surgeon can act in the same way and optimize "imitating" Nature through surgery.

This arises in the Hand through the "simplification of the carpus with concentration of the whole movement in the Coxa Manus" (s.c. Grail of Wrist Surgery). In the Foot, instead it arises with surgery that can correct the altered structure - mainly the TF and SF - towards anatomical normality - namely, towards the current phylogenetic standard.

Material and Methods. Cornerstone of this argument is the Primates Autopodial Phylo-Onto-Morfogenesis up to the constitution of Man's Hand and Foot. The aim is highlighting the anatomical-architectural similarities and environmental philo-ontogenetic conditioning that have defined their morphogenesis and functions in the human body. Starting from these assumptions, Coxa Manus's Surgery has been innovated in the Hand with surgery that optimize the natural adaptive processes and with the aim of recovering in the carpus the stability and proprioception of the center of rotation (located in the capitate head) and (at least) the basic range of motion, s.c. "Dart-Trowing-Motion".

Particularly useful and versatile in the clinical specifics of Adaptive Carpus is the Coxa Manus Reconstruction, consisting of a volar radiocarpal arthrodesis with resection of the distal scaphoid (radius-emiscaphoid arthrodesis), but also the Substitutive Replacement of Coxa Manus consisting of a First carpal row Resection with cephalic capitate prosthesis, in case of serious and irreparable damage. Similarly, the Systemic Foot Surgery has been innovated in the lower limb with these directives: 1) Optimization of the phylogenetic process; 2) Contemporary treatment of all deformities; 3) Search for stability, whereby the best correction is obtained at the bone; 4) Correction, in regression, of extreme damage; and with specific interventions - in the TF and SF - diversified according to the age of the subject, aimed at the long-lasting recovery of the best possible morphological fit.

Results. Exemplification shows some cases of extreme carpal damage treated with the Coxa Manus Surgery and, correspondingly, TF and SF disorders treated as the Systemic Foot Surgery dictates.

Conclusions. As discussed, it represents an heuristic bridge that connects Hand and Foot Surgery - for the first time, starting from the biological bases, with a higher and common point of view from which it is possible to achieve new surgical experience.

KEY WORDS

Coxa Manus, Goethe, Phylo-onto-morphogenesis, Sistemic Foot Surgery, Hallux Valgus, Flat Foot, Wrist injures.

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INTRODUCTION

In this study, the Philo-Onto-Morphogenesis of the appendicular skeleton is exposed and the corresponding "regressa" at the extremities of the limbs discussed, namely the Hand or Foot conformations that recall Ontogenesis early stages. Often, these emerge in the occurrence of anatomical damage, due to congenital, degenerative or post-traumatic pathology commonly known as "Dysmorphic"

Everything is revisited in a Holistic-Cybernetic-modern perspective, only apparently, as it has been already discussed by the Greeks 2000 years ago and in the Philosophy of Nature of the XVIII-XIX century - with clear re-edited concepts, including Physics and Biology, in each of their branches.

From this matrix, the laws of Form are drawn and proposed again and in the natural expression of the limbs' structure, inspired by Johann Wolfang von Goethe (Frankfurt am Main, 28 August 1749 - Weimar, 22 March 1832) - one of the greatest German minds, considered the founder of Morphogenetics.

Likewise, the conceptual tool of the Regression Principle (RP) is here created and used – as it is inherent to the Cybernetics of Systems Theory, according to which "*in biological structures, the anatomical insult tends to be configured as a re-enactment of the philo-onto-morphogenesis in an adaptive sense*". The RP is used to explain rationally the physio-pathogenesis of those alterations of the Hand (e.g., Adaptive Carpus, Carpal Instability, etc.) and of the Foot (e.g., flat-footedness, deformity of the forefoot, etc.). Namely, to explain all the "regressa" and corresponding "Dysmorphies" of common feedback and diagnosis in the usual clinical practice.

It should be noted that these assumptions are far from intellectual digressions. However, on the other hand, they provide a solid theoretical basis for concrete surgical applications to be used in cases of extreme damage. Respectively, with the Coxa Manus Surgery (GRIPPI, 2008, 2016, 2019) and the Systemic Foot Surgery (GRIPPI, 1986; PISANI, 1990; PAPARELLA TRECCIA, 1997), of which some exemplary clinical cases will be here shown and discussed.

MATERIAL AND METHODS

The optimal understanding of the object of Orthopedics "*the organs of movement and of the locomotor apparatus*", in addition to anatomy and physiology, should also extend to the knowledge of their "Origin", in historical-structural terms. Namely the "process" of how and why Nature could make them. Specifically, it concerns the process of the Limbs in general and (in particular) that of the Hand and the Foot of Man, in terms of Morphogenesis.

METAMORPHOSIS ACCORDING TO GOETHE WITH INTRODUCTION TO THE THEORY OF SYSTEMS AND THE "REGRESSION PRINCIPLE"

Looking for sources, we refer to Goethe who considered the Skeleton to be the fundamental design of Man and who had investigated extensively the meaning of the transformations of living beings. Namely on the "Metamorphosis": the "thing" and the "becoming" of the forms of the organisms (GOETHE, 1968, 1970; STEINER, 1988).

"... *and whirled up and down the primeval entity that encloses everything in itself and is alone and eternal, always changing aspect, always equal to itself* "(GOETHE, 2015).

To grasp its meaning, we must consider that he, a paradigmatic figure of European Romanticism, devised the cosmos as an immense totality in which the physical and the spiritual were indistinguishable: as a poet, writing in search of the ultimate truth of the soul, as a scientist researching the essence of biological forms.

Goethe (his works amounted to over 14 volumes of naturalistic writings) has influenced Lamarck, Darwin and Haeckel, becoming for us moderns the precursor of those holistic-organicist theses (anti-mechanistic and anti-reductionist). As we shall see later, these theses have been presented again in the Cybernetics of Systems Theory, and interpret the Organism and its Environment as "Systemic Totality" with emerging characteristics superior to the simple sum of the constituent parts. In this sense, the primitive entity mentioned by Goethe will be similar to the Monad (substantial form of Being) of Leibnitz which, as early as 1714, anticipated the systemic concept of the feedback (Leibniz, 1940): "... *without beginning or end ... without windows for which something can enter or leave ... subject to continuous change by an internal principle ... implying a multiplicity in unity ... although it has no parts ... every living entity has a dominant entelechy... but the members of this living body are full of other living beings ... each of which still has its entelechy ... everybody is affected by everything that happens in the Universe* ...". In any case, the entelechy is in perpetual transformation (Metamorphosis, in the living beings) while still remaining itself.

Initially, Goethe does not see it in the single organism, but as a vital principle that interpenetrates the universe, identifies afterwards the system of the Nature as a living being. Further on, he realizes that every work of Nature has its own essence, every phenomenon its particular concept "... *yet everything is one; even the disease and exceptional cases have a reason*…". The Cosmos with a vision that rejects any mechanism and randomness, which recognizes the perennial becoming as a semblance of the underlying Being, in a sort of Neo-Platonism (also, currently revalued by the Modern science).

It is in the his trip to Italy (1786-1788), the source of a "bath" of art and happy emotions, that the love of knowledge leads Goethe to see the essence of the primordial plant - the Urpflanze - in the infinity of the plant forms. In Padua and then in the Botanical Garden of Palermo, he notes that all the parts of the plant are only variations of leaves and that this applies to all the expressions of plant life that correspond to the concretization of an essential form. Each plant is a moment of the metamorphosis of such an entity that as a drive pushes from within so that inorganic matter self-organizes and takes on a certain form, and that by meeting the resistance of the external surrounding (environment, in a modern sense) it derives infinite variety (genera, species, etc.).

He writes of Palermo, in his diary: - "*In the garden near the Marina (port) I spent hours of sweet quiet. It is the most beautiful place in the world ...looks fairy*" - He even thinks he has found - "*among the green flowerbeds, espaliers of lemons ... and high palisades of oleanders ... exotic trees unknown to us ... of tropical origin ... that expand in bizarre intertwining* " - the primeval plant, identified by some as the *Ficus magnolioides*.

In the single plant, the monadic principle of Urpflanze is spatially actualized with alternate phases of expansion and contraction, generating organs of different shape (leaves, sepals, stamens, etc.) and yet substantially identical to each other expressing the underlying potential correspondingly (in adaptation) to the environmental context. The organism that derives from it follows the "Law of the Balance" or the internal equilibrium of the organs, according to which "*if a single part tends or is forced to develop particularly, the compensation of lesser development occurs in the rest, with reciprocal stimulus influences or inhibition*" - in a zero-sum equilibrium - between the parts, respecting one and immanent identity.

Goethe observes that in living Nature (because in continuous self-metamorphosis), nothing happens that is not in relation with the whole. In short, in the infinite variety of organisms the same law operates without distinction. The same criterion is therefore borrowed also in animals. In fact, since the spring of 1784, comparing skulls of various species could demonstrate the presence of the intermaxillary bone even in the Man who was considered to be devoid of it. This broke down the creationist preconception that prevented considering Nature as a continuum of animal forms that evolve one in the other - anticipating the evolutionary theses, still to come - and corroborated with certain facts the belief that even the animal forms are the result of the explicit of an immanent archetype.

Namely, the archetype of an animal type - the Urtier - which condenses its parts and summarizes all its possible othernesses and which takes place in the metamorphosis unfolding in successive transformations of identical parts, one next to the other (namely in time and space). Indeed, the organic parts of the animals adn everything else that can be observed are all the same structures that gradually change. The change happens until they become unrecognizable, mutating in something else (like becoming new structures and organs). This outcome is caused by the environment. This concept is clearly shown to him in Venice in 1790, on the occasion of his second

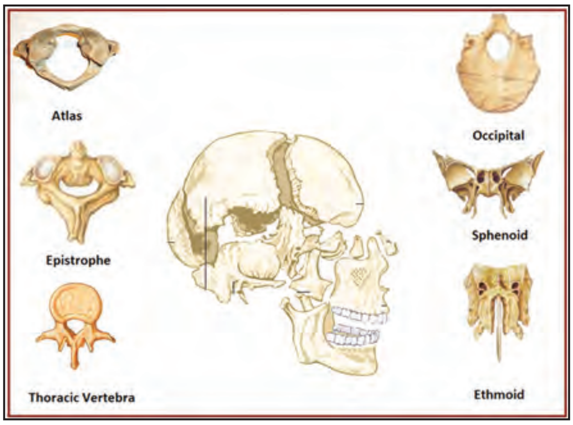

Figure 1. Goethe's Vertebral Theory states that the cranial bones are transformed vertebrae.

trip to Italy. The discovery of a fragmented goat skull in the constituent bones made him realize that they are transformed vertebrae, hence the enunciation of the Skull Vertebral Theory (Fig. 1).

Modern interpretation of the Goethian Metamorphosis

The Goethian Metamorphosis could be summarized (and reinterpreted) in the metaphor that the becoming of living beings and their structures is comparable to the flow of film frames that - in the narrative terms of Phylogeny (i.e., their appearance and differentiation in the course of Darwinian Evolution, starting from a common origin) and of Ontogenesis according to the Biogenetic law of Haechel (for which, the development of the individual represents a repetition of the evolution of his species) (HAECKEL, 1866, 1883; DARWIN, 1967; MONTALENTI, 1981) - recounts the history of the dialectic relationship between the Genetic Information (which would be, for the monadic entity, materialized in the protoplasm or living matter) and the Environmental Information (which would be for any external circumstance capable of provoking any kind of reaction in this same protoplasm).

Of course, this dialectic seems to repeat, unchanged, the ancient, irreducible dichotomies Spirit-Matter, Mind-Nature, Body-Soul, etc. Yet, the current culture of knowledge (Epistemology) has elegantly bypassed every mixture of physics and metaphysics in Cybernetics. In fact, today Epigenetics has widely recognized the dialectic role of the environment in the expressiveness of the genome.

Therefore, as anticipated above, we will reconsider every argument with the modern paradigm of Systems Theory, at the base of modern Epigenetics (VON BERTALAMFFLY, 1950, 1983; WINSDOM, 1951; SHANNON & MC CARTHY, 1956; BONNER, 1964; WIENER, 1966; WADDINGTON, 1977; MILLER, 1978; ROSSI, 1978; TANNER, 1981; BATESON, 1976, 1984; THOMSON, 1988).

Goethe in Orthopedics and complementary genes-environment interaction in limb morphogenesis

Applying Goethian thought to the foundations of Orthopedics, it follows that:

1) It is necessary to consider that the bone segments of the appendicular skeleton and related joints are all formally identical, so that any apparent diversity derives from the different environmental impact occurred in the Phylogenetic process. This is understandable in terms of a progressive adaptation and structural reorganization acquired in the predecessors towards the achievement of a specific "X" evolutionary advantage. In other words, their form is a a concrete function: namely a living protoplasm structured in such a way as to exhibit a behavioral modality, useful for survival.

2) From this initial identity awareness arises a priori that all the bones and their joint districts must have the same organizational plan in all observational levels (macro and/or microscopic) and that every situational and/or conformational difference (e.g., form, arrangement, number, thickness, etc. of the bones of the arm or leg, foot or hand) was dictated and has its raison d'etre in that specific mechanical context. In the same way that the shape of a key corresponds (even in complementary terms) to the keyhole. In principle, for a lot, you should be able to deduce (and get) one from the other.

A confirmation to this can be ascertained by the undoubted similarities of anatomical conformation (sometimes more easily observable in asynchronous phases of the ontogenesis) that the proximal humerus, the Talus in the tarsus, Capitate in the carpus, the proximal femur, etc. present between them. In fact, the data automatically indicates the similarity of movement while in the details necessarily relead to specific ways of using mechanical part (shoulder, wrist, hip, ankle, etc.): in degree and directions movement, stress strains, the levers used, in the amortization and friction dissipation, etc. (Fig. 2).

For the same reason, in the animal kingdom the skeletal segments present in Man are practically the same and, however, more or less diversified in relation to the mechanical-environmental context of operation, according to order, genus, species, etc. This is due not only to the common phylogenetic origin but also because "*the bones are the negative and complementary copy of the world's mechanical forces that each animal (in its particular habitat) must face and neutralize*".

From this, and by confirming again the current thesis of Epigenetics, it follows that the "form" (and efficiency) of the organs of movement is only minimally due to the genes, but that the mechanical confrontation with the environment is necessary (physical activity). In this sense, we speak about the osteo-muscular atrophy that occur in cases of paralysis or in subjects forced to some immobility.

In particular, some rules of Goethean morphogenetics - that we will find exemplified in the philo-ontogenetic and dis-morphogenetic process - also need to be clarified:

1) the metamorphose process is a continuum alternated in two fundamental phases: one of Systole, that is of energetic concentration, accumulation and folding of itself; the other of Diastole, that is energy expenditure, expansion and development.

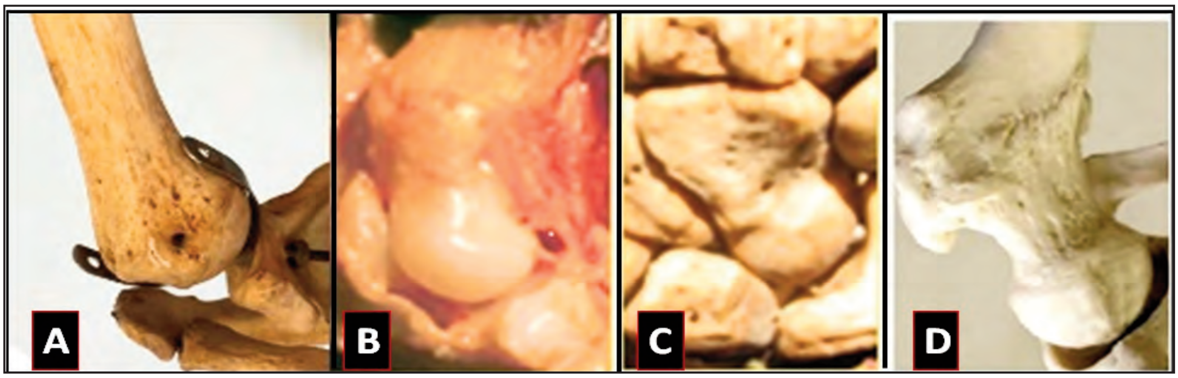

Figure 2. The anatomical similarities (sometimes more easily observed in asynchronous phases of onto-genesis) that the head of proximal Humerus (A), the Astragalous in the tarsus (B), the Capitate in the carpus (C), the head of proximal Femur (D), etc. present between them; they seem to indicate the origin from a common prototype.

2) for the whole organism, the Balancing Law is present, so "*nothing can be added or modified by a part without something being removed or modified by some other part, and viceversa*".

3) the environmental context (with its inputs) is decisive in determining and resolving the aforementioned processes.

Phylogenesis of the Tetrapod leg and Goethian Morphogenesis of the Man's hand and foot

Assuming for granted that the "shape" of the limbs is to be found in environmental causes (mainly mechanical inputs) that operated on the living protoplasm during Evolution, we will now examine the (principal) responsible for Phylogenesis and the relative morphogenesis of their anatomy. In doing so, we will follow Goethe's holistic-organicist vision.

First of all, the resistance of the water that primordial animals used for propulsive purposes. This was the input that in the Cambrian (540-500 MAF) has metamorphosed the primitive Chordates in Pisces with a hydrodynamic shape, equipped with movable appendages. The Fin - a real rising leg - has reproduced a structure in the animal body, a negative copy of the water environment. Namely, not hydrodynamics but what this entails is present in the fin conformation.

Then, in the Devonian (410-355 MAF) when the bony fish (Crossopterigi Repidisti) came out from the water, it collided with Gravity (G). The new input forced the fin to metamorphose into the limb: the bones increase in number and length, segmenting and forming articular joints for locomotion.

Thus, the limb of the Tetrapods develops in the amphibians of the Carboniferous (350 MAF) therefore, it structures itself to oppose it in contrast to the ground, to lift the body by means of muscle levers and then release itself so that, by controlled gravity fall, the forward thrust occurs - step by step, cyclically - with the joint parts directing the movement. The tetrapod limb therefore can reproduce the contrary copy of the forces existing on land.

In this sense, the conformation best suited to enslave G will result from the assembly of several bones - all formally identical but multiplied and metamorphosed into the copy-paste of the evolutionary lottery - constituting a proximal portion of anchorage to the body. The girdle (scapular and pelvic) prolonged distally with three articulated segments: Stilopodio (arm and thigh), Zeugopodio (forearm and leg) and Autopodio (hand and foot) - further distinguished in Basipodio (carpus and tarsus), Metapodio (metacarpus and metatarsal) and Acropodio with five digital rays.

This prototypical form is recognizable in all the extinct or current animal Classes derived from the Tetrapods: Amphibians, Reptiles, Dinosaurs, Birds, Mammals, Primates, etc. And yet, countless are the metamorphic variants that the most disparate environmental niches have produced, mainly in the Autopodio - on which from now on, we will (mostly) focus our attention on.

Firstly, terrestrial utilization provides a high mechanical differential input in the caudo → cranial movement directive (i.e., the body's progress towards the head). In the animal, this translates into anatomical divergence (in this case too it is a negative copy of the environment) of the extremities of the limbs. Then, the Anterior Autopodio assumes a directional set-up, while the Posterior Autopodio is propulsive. Thus, from the Reptiles to the Mammals and then from the Primates to the Man, two similar structures are formed and yet with a diversified mechanical structure: the Hand and the Foot.

The Hand and the Foot

In structuring, the pentadactyl formula guarantees the most advantageous base of support in the bone/surface ratio, and the directional stability is ensured by the "prehensile" play of the fingers (which push and/or leverage) on the ground. While the propulsive role of the Posterior Autopodio reveals itself in greater volume and thickness of the bones in the Basi-Metapodio (tarsus and metatarsus), the directional (and then also prehensile) inclination of the Anterior Autopodio expresses itself in greater amplitude and functional versatility of the Meta-Acropodio (metacarpus and fingers).

To this, we must add the inputs connected to the habits of food procurement: when it requires strength and speed, as in the carnivorous species, the bones tend to decrease and merge with each other; the opposite happens in the slowest herbivore and/or frugivorous species.

Moreover, the inputs of arboreal (movement) mechanics are added - on several occasions in phylogeny and fundamental for the metamorphosis towards the prehensile form of the original autopoda. In this direction, already in the Permian (295-250 MAF), the habit of feeding among the Gymnosperms (plants and fern trees, still without flowers) gives the front leg of the Melagalancosauri markedly prehensile characters, with five opposable fingers in the Meta-Acropodio to grasp the fronds to feed on and/or grab the prey.

However, in the Triassic (250-203 MAF), with the advent of reptiles-mammals and then dinosaurs, there is a decisive evolutionary leap in the mechanics of the shoulder girdle: some of these animals become bipeds with straight hind limbs in the ventral position and walk on their toes. In this way, the anterior autopodio, disengaged from the locomotion, develops more marked prehensile-manipulating characters (very similar to those that will then be typical of the Primates) (Enciclopedia Italiana delle Scienze, 1969). In fact, in some Saurisks, such as the Plateosaurus, the five-fingered foreleg is capable of prone-supination, with opposable thumb and second elongated finger able to hook the food (Encyclopedia of Dinosaurs and Prehistoric Life, 2001).

Important at this stage of evolution is the presence of a single carpal row, reduced to a pair of center-carpic bones contained by a broad fibrous meniscus, directly articulated to the distal radio-ulnar joint. In the lower limbs there is also a single tarsal row reduced to two or three centrotarsal bones, also contained in a wide distal tibio-fibular fibrous meniscus (Grippi, 2008, 2016).

We anticipate here that in the following evolution that will lead to the primates, the bone metamorphosis of above mentioned meniscal structures will then give origin to the first carpal row (scaphoid, lunate, triquetrum, pisiform) in the carpus, (while) astragalus, calcaneus and other minor bones in the tarsus.

Instead, in other carnivorous dinosaurs, such as the Jurassic Theropods (203-135 MAF), the forelimb specializes in a lethal weapon reduced to only three fingers with sharp claws. This is the case in the Maniraptors, in which the unique carpal row merges to form a large crescent-bone (homologous to the capitate-hamate bones), directly articulated to the distal radio-ulnar joint. This semilunar bone allowed to rotate the hand on the prey and with the prehensile fingers, then sink the claws into the flesh. This movement has been preserved in birds (the direct Theropods descendants) adapted to the flight.

It is interesting to observe how in the biped dinosaurs (i.e., in the *Tirannosaurus rex*) the limbs showed a notable dimensional dimorphism: small and weak the anterior limb, massive and powerful the posterior one. This is explained by Goethe's Balancing Law, whereby in these animals the uptake of the erect station and of the anti-gravity on the posterior limb subtracted an analogous morphogenetic input from the anterior one, which (for this reason) shrunk.

Something similar happened in the upright assumption of Man, so that the sexual dimorphism of the pelvis - being larger in females for gestation - has slowed the adaptive morphosis of the posterior limb, with potential patho-mechanical implications (such as example the higher incidence of the Hallux Valgus and/or Triangular Forefoot, in women).

However, at the end of the Cretaceous (135-65 MAF) any anticipation towards this prototype was stopped by the extinction of the Dinosaurs. But already in the Triassic, from the Synapsids were originated the Therapsid and from these the Cynodonts: the most ancient known Mammals, with decidedly prehensile front legs.

Thus, always in the Cretaceous, the adaptation to the arboreal life of primitive Insectivores leads to Primates (the most evolved order of Mammals, to which Man belongs too) with the typical structure of their limbs: quadrumanous, plantigrade, pentadactyly, presence of clavicle, ability of radius and ulna to pronesupinate, and lastly, almost always opposable thumb and big toe.

It happens, in fact, that in the ancestral species that Man has in common with the current anthropoid apes - for the phenomenon of evolutionary convergence (namely, the appearance of homologous structures in different animal lineages subjected to the same environmental inputs) - both the anterior and posterior limb are modeled on the upper limb of the biped dinosaur. Namely, they emancipate from terrestrial locomotion and develop prehensile-manipulating characters. However, they emancipate themselves from terrestrial locomotion and develop prehensile-manipulative characters, in a different food and environmental context and in the anterior and posterior basipodium it conforms a double bone chain and in the meta-acropod five digital rays with thumb and opposable big toe.

This structuring of the limbs takes shape during Brachiation (CRAIG BYRON & HERBERT, 2004) following the predominantly frugivorous diet, implemented with the advent of Angiosperms - plants with flowers originating in tropical forests 130 million years ago - for which the limbs further specialize: upper limb, in suspension hooking the body with one hand and using the other to pick-peel-eat the fruit; while the lower limb in the climbing locomotion in the new habitat full of trunks, branches and lianas.

At this point of the Evolution, Primates should be considered "children of flowers", since their conformation becomes the oppositional copy of the mechano-alimentary inputs acting in the Angiosperm forests. Namely, a structured living protoplasm (in the form of an individual organism) in what is necessary for their contrast-enslavement. The same applies to plants that, to better reproduce, metamorphose flowers and fruits to cajole their predators. All in a complex systemic network that also included insects (useful to both), a typical example of coevolution (joint space-time evolution of two or more taxa).

In general, among the phenomena that stimulate brachiation: the vertical ascent on the trees forces the limbs to extend and lengthen, the pelvic girdle and the rib cage to shorten and flatten (losing the carinated terricolous form) and the scapular girdle to dorsalize. Eating with the hands mitigates the feral prognathism of the snout and causes the skull to retreat and assume an ovoid-spherical shape so that the forehead becomes vertical and the eyes look forward. The prehensile locomotion between the branches forces the shoulder, elbow, hip and knee to widen the joint excursion, the ankle to interweave and together with the wrist to prone-supinate and the fingers to oppose.

In addition, falls from trees (which force the limbs to defend the body and the head) are the metamorphosing inputs of the peri-articular districts. Thus, protective structures appear capable of absorbing the traumatic energy and/or minimizing any damage. Among these: the acromion, the olecranon, the first carpal row, the trochanter, the patella, the medial and lateral malleolus of the ankle and the calcaneus. But especially in the extremities of the limbs - where contact with the environment is present - the advent of such defenses marks, also, the evolutionary transition from the Terapsids to the Primates.

In fact, the distal radius-ulnar meniscus of the reptilian carpus metamorphoses into the bones of Primates carpal condyle. Actually, in the current anthropomorphic apes and monkeys, the first carpal row (scaphoid, triquetrum, lunate and pisiform) helps to establish, stabilize and also protect (e.g., in falls) the enarthrosis of the Coxa Manus (CM) - constituted by scaphoid, semilunar and head of the capitate (on which the center of rotation of the carpus is collimated). Collaterally, this new mechanical arrangement optimizes grip capacity in the anterior autopodio and will serve to strengthen the use of the hands (which will then be completed in Man).

In the posterior autopodio, however, similar adaptations reinforce the propulsive role with the requirement of the prehension and ascent on the trees. This is achieved by opposing tibio-podalic rotations: so while the tibia rotates inside and at the same time enables prone-supination on the fibula, the forefoot is twisted into pronation and - to widen the grip - spreads in the metatarsus, conforming the first digital commissure with adduction of the big toe in opposition to the other fingers.

Also, in the tarsus (in analogy to the carpus), another row of bones appears, derived from the primitive tibio-fibulo-tarsal reptilian meniscus.

This meniscus in the digitigrade Terapsides is placed frontally (in continuity of tibia and fibula), as pulley of the flexors in the terrestrial locomotion. In fast predators, such as the *Syntarsus* of the Jurassic, it can be found as a single astragalus-calcaneus bone fused to the tibia and fibula (Fig. 3).

What happens in the tarsus is that the prehensile-propulsive inputs metamorphose the reptilian meniscus into numerous bones: the Astragalus and the Calcaneus well distinct in the backfoot, and others inconstantly outlined in the midfoot.

The astragalus remains inserted between the tibia and fibula in a dual role:

1) as a leg bone, it focuses and widens the dorsiflexion of the foot (to encourage the ascent-descent from the plants);

2) as a bone of the foot, it is prolonged in the tarsus to form the Coxa Pedis enarthrosis, constituted by the distal-oriented head of the Astragalus and, with its center of rotation, on the scaphoid and calcaneus, in a cardan-like assembly - optimal in the kinetic transmission, namely, of the motion and power, between forefoot and leg referred to a firm base, namely, trunk or ground. This allows to take full advantage of the impulsive stresses of the muscles and, thus, to enslave the consequent reaction to support the movement of the animal body.

Instead, in the heel, posterior tuberosity is developed functioning as a lever and fulcrum (like a sesamoid bone) of the gastrocnemius-achilleus-plantar apparatus, which acts as a motor and propulsive transference. Moreover, in the s.c. trip under the talus of the calcaneus, in a reciprocal twisting, the bone slips under the talus. In this position, also, the role of shield to protect the talus from any impacts, as animals that lived on trees were subjects to frequent falls (Fig. 4).

Finally, the posterior autopodio structures the s.c. “Elica Podalica” (or Podalic Propeller) by Paparella Treccia (1977) by the variable spatial ratio between the rear foot (in the vertical plane) and midfoot-forefoot (in the horizontal plane). This - in terms of structure and living form - actualizes in the animal protoplasm the (negative) complement of the (positive) mechanical forces of the arboreal environment.

In the Pliocene (7-3 MAF) then, it is assumed that in the African Rift Valley some kind of anthropoid apes - forced to leave the forest due to the high grass of the savannah - (re)adapts to live on the ground. The return to the gravity input compels the general postural change with relative metamorphic revisions, mainly in the posterior autopodio. For the visual control on the prairie and to continue the manual feeding, it is indispensable the assumption of the erect position. Consequently, the center of gravity is raised and withdrawn, the vertebral curves appear, the pelvis and lower limb extend. However, the arboreal foot is relatively too loose and flexible to tolerate all the weight and (bipedal) locomotion of the animal. Therefore, in the evolution that will lead to Man, we witness the progressive stiffening of the Elica Podalica in an anti-gravity sense with recession from the prehensile attitude, now useless (Fig. 5).

In detail, the ankle loses the prono-supination of the distal tibio-peroneal and develops the malleolar saliences to act as a track and spur to the astragalus which is horizontally oriented. The heel increases in volume, completing the sub-astragalic process. This is the first contact on the ground and the fulcrum of the propulsion lever developed by the forefoot.

In the tarso-metatarsal plantar, arches, transversal and longitudinal, are developed, for which the medium-tarsic bones (scaphoid, cuboid, I-II-III cuneiform) - which are almost absent in the Eocene tree primate (40 MAF) - hypertrophy (with foot extension) and take a wedge shape. Thus, the whole foot metamorphoses into a two-arm joint lever: metatarsal-tarsus - (astragalus) - calcaneal tuberosity - with the fulcrum balanced in the center of rotation of the astragalic head (Coxa Pedis).

Thus, through the Coxa Pedis forward and back under the tibial pylon, the weight of the body is transmitted and cushioned in the anti-gravity reaction to the ground. This movement, during the journey, is characterized by the functional alternation between the medial and lateral segments, respectively: Calcaneus and Astragalic Foot of Pisani. The first one as support in the supporting phase, the second as a propeller (virtually prehensile to the ground) in phase of detachment.

At the same time, the metatarsal fan is closed in the forefoot, the first commissure disappears and the bigtoe loses all opposition. All the fingers are shortened (by Goethe's law, in favor of the prolongation of the midfoot) and their prehensility is replaced by the

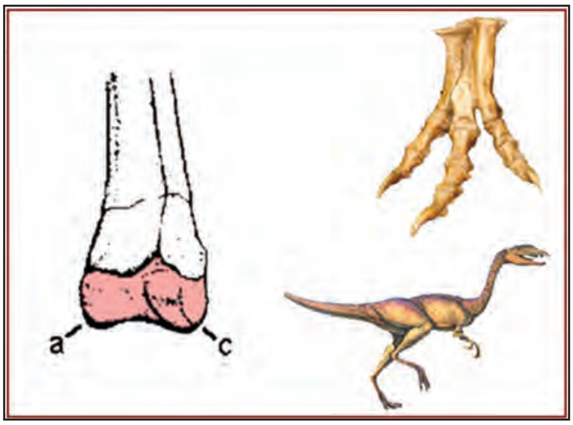

Figure 3. The primitive tibio-fibulo-tarsal reptilian meniscus, from which the astragalus and the calcaneus of the Primates originate in the digitigrade Terapsids, is ossified and placed frontally. It is the only astragalus (a)-calcaneus (c)bone fused to the tibia and fibula in fast predators, such as the *Syntarsus* of the Jurassic.

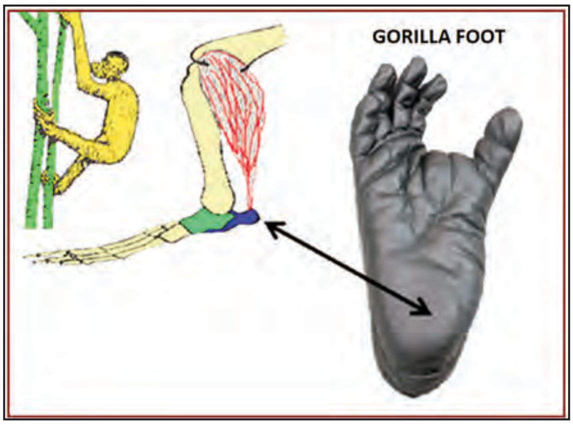

Figure 4. During the Brachiation of Primates, the foot amplifies prehensility, while the reptilian tibio-fibulo-tarsal meniscus metamorphoses the astragalus and calcaneus with the meaning of the sesamoid fulcrum of the achilleo-plantar apparatus. The heel (also) assumes the role of protection shield of the tibio tarsic joint.

thrust of propulsion from the ground, especially in the big toe, which hypertrophies together with the I ray. Finally, the sum of transformations corresponds to the structuring (in negative) of the mechanical inputs of run and bipedal jump, certainly, in such anthropoids, prompted by the various activities carried out in the savannah (Fig. 6).

In the upper limb, instead, the prehensile inclination is strengthened. Above all, in the Hand, the manipulative attitude with of tactile gnosis and interdigital grip strenghten. In fact, in the carpus, the configuration of the Coxa Manus - with the head of the capitates proximimally oriented - attests that the articulation has a privileged reference to the retained arm. This allows the possibility of fine and circumstantial movements, such as the use of a flint or an awl, finalized, therefore, to the taking and maneuvering of tools.

All this, combined with the bipodalism, is a (probable) trigger to the symbolic thought of the brain, thus completing the process towards the Homination. In returning to the ground, however - unlike the diminutive front leg of the biped dinosaur: prehensile, but lacking in manipulative capacity - the upper limb retains the good tropism of the apes, and the Hand develops the sophisticated intrinsic musculature that allows finer movements and the powerful use of the Thumb. All this to denounce the morphogenetic role of the mechanic-cultural inputs acting on the arms and hands, originating from the use of tools. In particular, those attributable to the use of weapons, the handling of objects and with the Civilization the advent and diversification of Work, etc. (Fig. 7).

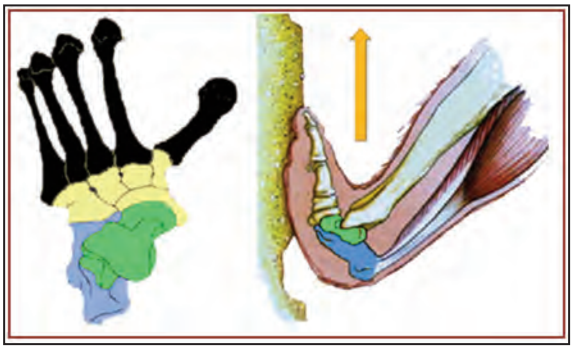

Figure 5. In the evolutionary process that will lead to Man, we witness the progressive stiffening of the Podalic Propeller (Elica Podalica by Paparella Treccia, 1977) in an anti-gravity sense.

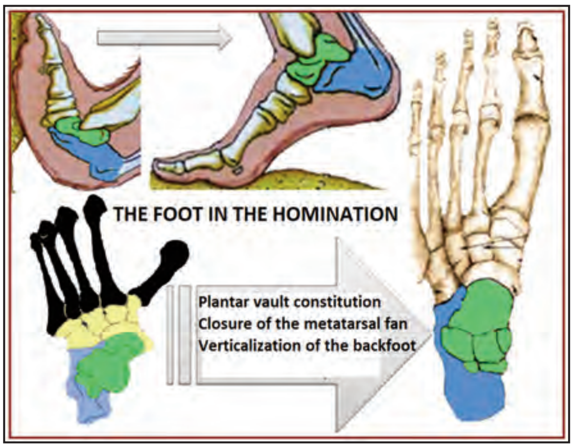

Figure 6. The metamorphosis of the arboreal foot returning to the ground corresponds to the complementary structuring (negative copy) of the mechanical inputs in the running and of the bipedal jump.

Immanence of the morphogenetic process in the architecture of the Hand and in the Foot and its reenactment in structural damage

It is certain - in view of the Biogenetic Law - that for each generation, the aforesaid process is repeated and immanent structured in the forms and functions, intrinsic to their architecture.

In fact, the existence of individuals walking on their hands is documented or those who, without these, use their feet to eat, wash and even paint. In practice, it is verifiable - not only in certain playful behaviors, but also in pathological situations: the realization of a Regression. Therefore, as in the onion or in the tree in which any cut reveals the stratification of the growth lines, in the same way, in structural damage (insult to the living Monad, in the Goethian sense) - with alteration of the morphology (dysmorphism, in the broader sense in the Hand or in the Foot) - functional and/or structural assets of the phylogenetic past can be reenacted.

This reenactement - understandable in the certain anatomical fact that "... *each part condenses its evolution and summarizes all possible otherness* ..." (Grippi, 1986) - is not at all chaotic. On the contrary, it manifests itself in a logically interconnected way to the rest of the organism, with a general law that we have deduced and found in many other aspects of the general pathology and that we have, therefore, called: Principle of Regression.

To expose this principle according to our specific interest and in clear scientific terms, it is useful to continue with the arguments of the Cybernetics of Systems Theory which, as anticipated, proposes the same concepts of Goethe in the wider epistemological field and in the paradigms of modern science. In particular, in considering the relationship Organism-

Figura 7. In Homination, the upper limb retains the tropism of the apes and in the Hand it develops the sophisticated intrinsic musculature for the mechano-cultural inputs originating from the use of tools.

Environment (a multi-relational process) inserted in a Systemic Totality.

CONCEPTS OF CIBERNETICS AND SYSTEM GENERAL THEORY (SGT)

The term Cybernetics was introduced by Wiener in his book of 1948 (Wiener, 1950) and is derived from the Greek word *kubernetikè* (helmsman). This term refers to an aggregation of ideas also called theory of communication, theory of information, systems theory, etc., which concern control and communication in animals and machines.

In biology, Cybernetics states that animal activity is not due to a vitalistic principle (soul, etc.) but depends on the specific organization of the matter present in the organism. Thus, the properties that living beings seem to miraculously benefit from would be due to quality of non-living matter "emerging" when the atoms that constitute it aggregate in the form of organic molecules (cells, tissues, organs, etc.) arranged in configurations with a high organization, or "information content" or "*negentropy*". In other words, biological organisms - including humans - are their structure. Namely, organized matter.

In other words: *Structure = Atoms + Organization*. Therefore, the living beings are a condensation of information. And all the phenomena that concern them, including pathological ones, are identified with the processes of transformation that this information undergoes. With these affirmations, every metaphysics disappears from Science, and for the first time in the history of thought, it is possible to treat in a single theoretical body both the mechanisms of nature and life and those of human history and technology.

The isomorphism of the sciences and the living organisms as open systems

The basis of Cybernetics is the concept of System: an entity made up of a combination of elements interacting and interdependent, united to create a phenomenon, a function, an event. Each element can itself be a system made up of other elements, themselves systems, and so on.

The last proposition derives from the General Theory of Systems (GTS) (Von Bertalanffly, 1950, 1983). According to the definition given by its author, Von Bertalanffly: "... *discipline that considers the properties of the systems ... regardless of their nature* ..." on the basis of a general "isomorphism" of systems. This term that indicates the fact that formally identical laws can be applied to apparently different systems. More generally, GTS is a coherent set of definitions, assumptions, and propositions that consider reality as an integrated hierarchy of matter and energy organizations in the form of systems. The behavioral theory of general systems concerns a special subset of all systems: Biological Systems.

Living organisms, in fact, can be considered as open systems. Thus, able to exchange matter and energy (information) with the surrounding environment, and part of a hierarchy of systems that includes the whole universe: going through the systemic hierarchy - from the atom to the galaxies - the living organisms occupy a band between the virus and the entire Earth's ecosystem. In turn, the organisms are made up of a hierarchy of subsystems.

Thus biological systems are open and can be transformed. In fact, the constitution of organisms and their morphology change over time with processes of development, growth, senescence, etc. Their stability is only momentary and achieved by a continuous dynamic balance that maintains an apparent steady state by means of automatic regulation mechanisms that operate according to the principle of positive or negative feedback. Namely, any change in the state of the system involves a return adjustment that allows you to adjust the extent of the change in some way, because it does not exceed certain predetermined critical values - it is the same principle on which the thermostat's regulating action is based in a stove. With regard to organisms, such retroactive servomechanisms are called homeostatic, while their complex is indicated with Omeostasis.

The structural complexity of a biological system can be expressed in terms of the organization of the matter that constitutes it: informative content or negentropy. Generally speaking, in the development of the biological system, whether considering the whole ecosystem or the single organism, there is a general increase in negentropy: at the ecosystem level this increase is summarized by the Phylogenesis process; on the individual level, however, in the Onto-morphogenetic process (Epigenesis), in which, starting from a single fertilized cell (zygote), an entire organism develops. Phylogeny and Epigenesis, as already mentioned, are linked by Haechel's fundamental Biogenetic Law according to the well-known aphorism "*Ontogenesis recapitulates Phylogeny*" (13: 14).

The human organism according to the Systems Theory and the etiology of the dysmorphic event

The human organism can be considered an open system which is part - at various levels of participation and at the same time - of more complex systems. Thus Man is an element of the family system, of the company system in which he works, of the state system, of the eco-system, etc. In turn, the organism consists of hierarchies of systems consisting, in turn, of "n" microsystems and so on, starting from macromolecules, organelles, cells, tissues, organs, apparatuses gathered in functional complexes used for different functions: the perception of the external world, nutrition, reproduction, locomotion, etc.

Each of these systems is imbricated and interdependent with all the others and can be studied separately only on condition that it is considered part of the systems in which it is incorporated. In any case, the functional activity of a system or of each single subsystem is further divided into smaller subsystems. The functional activity of these subsystems represents its qualitative aspect.

In general, every function performed by the organism - in its entirety or specifically by some of its anatomical parts - corresponds to a cybernetic system with its own information flow, with an input (signal input) and an output (signal output) and feedback servomechanisms directed to the control of some physiological, anatomical or functional variable that is identified with the purpose, function or activity to which the system itself is responsible.

Considering the human organism in a systemic key means that, having identified a certain function, we can go back to a system, examine its constitutive and functional aspects, the interactions with other systems and the environment and, applying the laws of system interaction (by virtue of system isomorphism), deduce its implications in the clinical field by comparison with what is already known. If not, in some clinical cases it allows the development of new theoretical assumptions and working hypotheses to be submitted to the verification of clinical observation or experimentation. In our specific case, this isomorphism has allowed to assimilate the Cybernetic Systemic with the ideas of Goethe.

For example, the function that keeps the organism "alive" can be traced back to Architectural Maintenance and Trophy System (AMTS).

Architectural Maintenance and Trophy System (AMTS)

This system is identified with the sum of activities necessary for the living protoplasm to organize and maintain its structure over time (Grippi, 1986). The building blocks come from foods that also provide energy for vital processes (inputs). In the whole organism, the system's task is to realize the conformation of the anatomical parts both during onto-morpho-genesis and post-natal development. At the end of the growth it continues to act on the body structures, maintaining their efficiency with continuous homeostatic processes of rehash and trophic maintenance, as well as repair during degenerative or traumatic offenses occurred in the course of life (output).

The system begins to function after the zygote is formed at the time of fertilization and coordinates its ontogeny. Its purpose is to increase and maintain the architectural organization of the developing organism as long as possible. Namely, to increase and maintain its informative content or negentropy. For this to happen, foods are disassembled into simple molecules and reorganized into cells, tissues, organs, etc., due to a dual flow of information that is expressed by a morphogenetic program that concretizes a certain organic form.

This dual source of information, capable of implementing inorganic molecules in organic structure (protoplasm), consists of:

1) - the *Genetic Information* - in the chromosomal DNA-RNA (and probably, also in the proteins) - of the genome

2) - the *Environmental Information*, represented by all the events of the external world (input) able to provoke a reaction in the protoplasm.

With regard to the trophism of the limbs, the environmental component is largely identified with the tensile-mechanical forces (so-called "load" or "engineering effort"): corresponding to a specific measurable physical force acting on them (so-called biomechanical effect) .

As best discussed and illustrated below, the load is generated by a hierarchically related super-system: the Load Transmission System.

The individual morpho-phenotype - that is the appearance and the becoming of the anatomical parts of the organism - is the result of the complementary competition between environmental information and genetic information, which is also equivalent to considering the form as a relationship (meta-communication): *Genome (G) + Environment (A) = Morphotype (G+A)*.

This equation represents the fact that the genome normally needs environmental stresses to produce the normal morphotype. Therefore, for the normal development and maintenance of the trophism of the limbs, the tensile-mechanical stresses are indispensable from the beginning and throughout life.

Moreover, during the cycle of individual existence the relationship between genes and the environment is subject to relative variations in the respective terms. In fact, the genetic program is very active in the growing subject compared to the adult. In the elderly, instead, it is practically silent. Similarly, the tumultuous motor activities in childhood and youth stabilize in the adult. However, they are reduced in the elderly by the supervening weakness of the structures.

In clinical terms, this means that the morphotype varies over time and that the macroscopic and microscopic (ultrastructure) anatomy of the systemic complex is in perpetual metamorphosis. These incessant transformations are the tangible manifestation of a state of dynamic equilibrium and indicate, precisely, the presence of a cybernetic system whose homeostasis depend on the development, trophic maintenance, the shape of the supporting structures, from the rachis to the foot.

Moreover, from the equation we can deduce that the morphotype may not be correct (i.e., not statistically normal) if one of the two informational terms is anomalous. Thus, in the limbs, the genetic anomalies, but also, to a lesser extent, the tenso-mechanical anomalies, can contribute to the development of structural pathologies (dysmorphic structures in the broadest sense).

As we shall see, these concepts express the general etiological basis (the causes) of the Dysmorphies, in particular in the lower limb and in the foot, more or less always mechanically stressed by the environment, being in contrast with the ground.

Pathogenic noxa and functional reserve. The cybernetic adaptation, the Regression Principle, the pathogenesis of the dysmorphic event, surgical implications

The condition that stabilizes the vitality of the biological system is that its homeostasis, disturbed by the external environment, is able to effectively oppose these disturbances. The comparison, however, must take place to the right extent and within certain limits, outside which homeostasis is disrupted and the system is at risk of decomposing.

The perturbing event is, in general, an activity from the external world. This activity is, for example, the stimulus that activates the sensory receptors in the perceptual process, the effects of gravity on the body, the introduction of food etc. In all these cases, the external environment penetrates the biological system promoting its activity, through physiological adjustments. When the external environment bursts into the system, definitively altering homeostasis, it is configured as a “*pathogenic noxa*” (pathogenic, in the broad sense). In this case the system reacts retroactively in an attempt to restore homeostasis.

The sum of these activities (such as fever, cough, repair of a fracture, limping, etc.) represents the disease state, and if the noxa exceeds these adaptive responses, the systemic complex can be irreparably damaged by more with the subversion of the anatomical structure of some of its components and, in the most severe cases, even with the blockage of some vital process. This event, in cybernetic terms, corresponds to the reduction of information content or negentropy of the system: the infarct necrosis, gangrene, senile decay or death with putrefaction, represent in fact various possibilities of degradation of the biological systems.

The amount of reactive capacity of a system towards a noxa can be defined by the term “*functional reserve*” of that system. The action of the functional reserve allows the system to maintain its stability and its dynamic balance by adapting it to the pathogenic noxa. Adaptive behavior is complementary and opposite to noxa: it is the reaction to aggression. The danger consists in homeostatic degradation towards decomposition. Therefore, the imperative of the system is to remove the noxa. However, this is not always possible. Alternatively, the system will use its functional reserve in an attempt to neutralize it.

When this goal succeeds, a new equilibrium is established and, as a final effect, the functional reserve decreases, which will then be reintegrated with the convalescence. If, on the other hand, the functional reserve is overwhelmed by noxa, destabilization will involve the hierarchically related system or microsystems, which will react with their functional reserve and so on until the noxa is neutralized or, at the extremes, until death. In the positive cases, at the end of the process, there may be completely destabilized microsystems and the definitive loss of a part of the functional reserve of the neutralizing systems that can be found with compromised structural elements. This is the case of sickness. From a medical point of view, this corresponds to anatomical damage and functional limitation. In such cases, the death of the system did not occur, but its overall information content diminished, especially in the components that directly addressed the noxa.

Since the biological system is a consequence of the Filo-ontogenetic process, the pathological decrease of its information content, in the damaged parts, occurs tracing back the same process.

This property, although not clearly formulated in the GTS, is at all verifiable as generalized isomorphic behavior and can be enunciated as Regression Principle. Namely, "*in a system whose development, in terms of structures and functions, occurred progressively over time, the destabilization of homeostasis, however determined, involves the re-emergence of functional activities and structural assets belonging to the past of the system itself* " (Grippi, 1986).

In destabilized biological systems, this principle manifests itself with the re-emergence of anatomo-physiological structures that recall structures and functions similar to those that the system or micro-systems, specifically affected by the action of noxa, presented at an earlier stage than their current phylogenetic development. Thus, each adaptive state is basically a regression that, in the involved parts and in relation to the interested systems, can manifest itself in the form of anomalous anatomical-physiological structures with less information content, which evoke structures and functions already taken in the ontogeny and present, therefore, in phylogeny.

Some examples: brain injuries involve the re-emergence of subcortical functions, dementias correspond to the drift (in the authentic sense of return to intellectual and behavioral functions typical of children), the physical decay in the old (or, in subjects with exhausting jobs) corresponds to the degradation of the body structure with the smoothing of the vertebral curves, the caudo-ventral translation of the appendicular tracks, the thoracic fairing, etc. Or, trivially, the heart rate that increases in stress or heart diseases assuming rhythms and frequencies typical of embryonic stages, etc.

Strictly speaking, all this is perfectly logical: just as building a house starts from the foundations and, slowly after, it builds up to the roof, in the demolition the process is inversed, reversing the flow of time.

But even more surprisingly, this natural logic that presides over the destructuring of the living being, specularly, also seems to coordinate its structuring. As proof of this, a significant regressive event is the phenomenon of *Neoteny* (or juvenilization). Namely, a form of protracted immaturity (Bolk, 1894). Therefore, in the phylogeny, old structures diversify new anatomical contexts, through the casual persistence in the individual adult of some regressed structure, typical of ontogeny. The change thus obtained would then be selected. Namely, transmitted and reinforced in the descendants, if it is an adaptive result to a new and complementary environmental input.

In this regard, there are numerous biological evidences, such as the transition from Chordates to Pisces or from Primates to Man, etc., that attribute this phenomenon as a start of the evolutionary metamorphosis. So, in the end, it is legitimate to conclude that the Regression Principle, too, determines the phylogenetic "becoming" with the diversification and/or evolutionary innovation of a certain organism, that changes into something else, without necessarily having to resort to an infinite number of point genetic mutations. All this could simply correspond to a remodulation of the ontogenetic maturation between pre-existing "old" anatomical parts obtaining a different and/or new anatomical configuration in the adult, then transmitted as such in the next generation and so on.

In this case, the change (evolutionary leap) is a meta-communication that involves the upper level of the operational rules and that does not concern the genetic message itself, but the local flow of its informative potential. That is not the lexicon, which basically remains the same, but the (temporal) syntax of its morphogenetic expression.

In this remodulation, any new environmental input (environmental information) the current phylogenetic stratification of the genome, properly, the physical accumulation of genetic memory encoded in DNA. Such inputs also directs its phenotypic expression at different levels in the systemic hierarchy, re-editing solutions of the past that can oppose or favor the new input, to select - bring out, by trial and error - a new (systemic) assemblage better suited. Namely, the one suitable to act as a key in that specific environmental lock. This reshaping spreads adaptive change in many anatomical sites (systemic levels) simultaneously - in this, adapting to Goethe's balancing law - with an apparent finalism and a coordination that has nothing miraculous, but which instead represents the most flashy epiphenomenon energy rebalances (information flows, homeostasis, etc.) that the systemic hierarchy of the organism implements, and suffers, in opposing the environmental counterpart.

The aforementioned dynamics clarifies how the same genomic pool, especially in the lower organisms and / or in plants, etc., as environmental conditions change, can give rise to organisms that are also notably different, often reproducing a variable mix of prototypical ancestral forms. It is thus conceivable that, in the geological time, from the cumulative genomic summation of many (small) local regressions were generated (starting from a few, simple basic conformations) all the structures and living forms: Taxa, Types, Genres, Species, etc. with the corresponding (and complementary to their environments) anatomical diversity.

Towards a Systemic Surgery

However, in our specific case, the assumption of the Regression Principle is the conceptual basis for the understanding of the general pathogenesis of the dysmorphic event (i.e., the logic with which it is expressed clinically) in biological structures. In relation to the purpose of this work, also of congenital and/or acquired Dysmorphies in the foot and in the hand of the s.c, inborn "adaptive carpus" and/or acquired post-trauma. Thus defining a new biomechanical-systemic view of these structures and a new surgical-systemic methodology aimed at solving any anatomical damage.

We anticipate that this practice considers the surgical act as an environmental input - deliberated by the surgeon's conscious mind - introduced into the systemic hierarchy with the aim of (in)forming the suffering structure in the direction of the norm. This means, in reality, to act in the totality of the patient in the environment in which he lives and works. Hence, the enormous responsibility for the infinite variables to be considered.

However, untangling the maze of empirical possibilism is the Arianna thread of the Regression Principle and the derivative surgical methodology. This involves the completion of the local epigenesis in the damage due to local regression (e.g., in the correction of the clubfoot, flatfoot or hallux valgus, etc.) or functional optimization (always implemented surgically) of a local regression at the highest phylogenetic level still compatible (e.g., the transformation of the mechanical and structural bones of the wrist, similar to the carpus of the Dinosaurs) to be carried out in the “adaptive carpus” from irreparable damage to the radiocarpal joint, etc.

"SYSTEMIC" ONTOGENESIS OF THE HAND AND FOOT AND REPLICATION IN DISMORFIC AND META-TRAUMATIC DISEASES

It is to be specified that with "dysmorphic structure" or "Dysmorphia” we mean a congenital structural and/or acquired anatomically incorrect. Namely, not statistically normal according to the classical Gauss distribution curve. The dysmorphism will be thus defined in cybernetic terms, and classified in the field of Systems Theory, with the enunciation of the “*Dismorfogenetic Law*” following the application of the Regression Principle to their pathogenesis.

To exemplify cases of common clinical confirmation, with the warning that the acquired dysmorphism of the Hand and Foot - compared to those congenital - are determined primarily by environmental factors, with different input agents. Respectively:

1) in the upper limb, we have firstly the high-medium energy traumatic input and secondly the mechanical-micro-traumatic (occupational over-use, etc.) and / or degenerative-phlogogenic (rheumatic-arthropathies, etc.).

2) in the lower limb, we have firstly the mechanical-micro-traumatic input of the "load" and secondly the high-medium energy and/or degenerative-phlogogenic traumatic input (rheumatic-arthropathies, etc.).

Ontogenesis of the limbs and epigenetic comparison of the Hand and the Foot

It should be noted that the actuation and the metamorphic becoming of the limbs follow alternating phases of Goethian expansion and contraction (in ontogeny), clinically evident mainly in the growth of the child, from which:

- Turgor I of weight gain (2-4 years);
- Proceritas I of extension (5-7 years);
- Turgor II of muscular increase (8-10 years);
- Proceritas II for further extension (12-14 years);
- the Turgor III of further volumetric increase (14-17 years),
- the post-pubertal period (17-20/23 years) still elongation (in males), which complete somatic growth, etc.

Likewise, each segment of the developing limb follows the Balancing Law, so that any anomaly of conformation and/or local growth inevitably involves the compensation for altered development and/or structural adjustment elsewhere, etc.

To highlight this phenomenon in the medical examination and for the further discussion on the dysmorphic mechanics of the lower limb (and of the foot, in particular), it is now useful a brief digression on the concept of “load” and related implications anatomical-functional in the human organism.

Load Transmission System (LTS) (of the Human body)

This system (Fig. 8) includes all the structures of the body responsible for the transmission and mechanical use of the load. They are:

1) *elements predominantly stressed in compression*. Namely, those supporting skeletal components (rachis, pelvis, lower limbs) which, for this purpose, present an ultra-structural organization in bone trabeculae arranged along lines of force.

2) *elements mainly stressed in tension*. Namely, the muscle bundles from the rachis to the foot, with the associated periarticular tendons and ligaments.

The activity of the system starts in the foot-ground contact with the s.c. *support reaction*. This generates the load (analogous of the engineering "*effort*"), which can be defined as "*the force exerted by the body of mass (m) subjected to the acceleration of gravity (G) on the plantar surface (S)*".

Namely: Load = mG / S. This force in the erect subject and at rest coincides with the body weight. In the accelerated movement, however, we need to consider the inertial reaction that can raise (even a lot) the load per unit of plantar surface (e.g., in running, jumping, etc.).

It is here to remember the fundamental role played by the load in the phylogenetic determinism of the conformation of the tetrapod limb. This, in fact, corresponds to the negative copy of that. Namely, not the load but what this entails has been "concretized" in the form "tetrapod limb".

However, in Physics the load corresponds to the energy of elastic deformation accumulated among the molecules of matter when stressed by a force (Gordon, 1979). On the contrary, in cybernetic terms, due to the fact that the molecular organization is modified (reversibly), it is an environmental input that enters and traverses the aforementioned anatomical elements in succession - performing, among other things, by virtue of the aforesaid "molecular pumping", a beneficial and irreplaceable trophic-mechanical action at the level of the hierarchically related subsystem: the Architectural Maintenance and Trophy System (AMTS), illustrated later (see page 35).

In reality, it is the impulsive forces of the muscles and of the inertia that, while contrasting G, produce in the support reaction the load, as an input identifying the system. The output, on the other hand, is the dynamic balance that takes place between the micro-deformation induced in the stressed structures and their tightness. From the loss of this balance, in the respective terms, the possible pathogenic action of the load derives. Namely, if the load is excessive compared to a normal structure, it can break or collapse (e.g., in a fall). On the contrary, if the structure is weakened by acquired (f.e. osteoporosis, rheumopathies etc.) or congenital factors (e.g., Marfan or Ehlers-Danlos disease, etc.) even the normal load can deform it.

Since all the components of the system are interconnected, the reaction to the load exhibited by a given element depends not only on its structural specifications but also on those of the other elements. In this sense, the sexual dimorphism between the males and females of our species actually verifies that the function of the system is closely related to anatomy.

In fact, in the woman, the pelvis as an element of the system is, at the end of growth, of conformation and size relatively greater than in the man with the same body size: it is more inclined, wider, less tall and less thick, with greater distance between the femoral acetaboles.

Sexual dimorphism is supported by endocrine and auxometric differences. However, certainly, every difference derives from the natural selection that working on the female body has favored, first of all, the functions connected to the survival of the species. But, to structure the woman in gestation and childbirth, Nature had to adapt elsewhere (following the Goethe's law of balancing). In this case, the economy seems to have concerned adaptation to bipedalism, with easier tendency to pathological deviations in the system (Fig. 9).

In this regard, it is known that in girls the appearance of femoral tibial anomalies is easier, such as the delay of physiological femoral detorsion with subclinical manifestation of an antiversa coxa (hip) which, in general, resolves spontaneously in 80% of cases (Gluber & Vizkelety, 1966). However, this resolution may be suffered, with pains in adolescence, or incomplete, because the bone structures can remain fixed by the relative early closure of the growth epiphyses, unlike the male peers.

In this case, the destabilized systemic complex tends to activate a series of adaptive phenomena (of homeostatic rebalancing) represented by morphofunctional compensations spread throughout the systemic hierarchy, corresponding to the functional reserve mechanisms of each single subsystem according to its potential. Among these, for example: the reconfiguration of the cerebral movement patterns, the appearance of a vertebral paramorphism (lumbar hyper-lordosis, kypho-scoliosis, etc.), the intra-rotation of the limb, etc.

These adjustments (initially functional) can, if they persist over time, be structured and highlighted in the clinic - e.g., the decrease in the angle of Fick's step, the convergent patellar squinting etc. or, in the foot, with the disorientation of the compromise axis of the subtalar along the progression line of the march or with the functional (static) pronation of the forefoot (Pisani, 1976), etc.

In particular, the static pronation of the foot (easily observable in the podoscope in both sexes, but especially in girls) has a "regressive" character that corresponds to the adaptive recovery of the "ancestral prehensility" of the ray and possesses a certain valence in normal development, as a functional attitude, transitory and limited to the evolutionary age, that accompanies the growth shots of the "Proceritas". Therefore, it is useful to favor the physiological detorsional process of the limb which, for all childhood, tends to lengthen in intra-torsion. In this case, it is actually verifiable that environmental information (load input) is complementary to DNA genetic information.

On the contrary, in the subjects, male and female, with genetic insufficiency of the aforementioned process - and, also, in those that suffer an environmental screening, due to the incongruous application of orthotic insoles or corrective orthopedic shoes - it can deviate in pathological situations. In fact, in the growth adjustment, those skeletal parts still susceptible to modeling, stressed by the load, are induced to change shape correspondingly, so as to minimize and spread the stress on the entire structure. This in the physiological condition, would harmoniously occur throughout the body, following the Goethian law of balancing, with the final result of a "normal" conformation.

In the pathological condition instead, it would be a disharmonically conformation with dysmorphism often strictly localized. In this case, among the numerous clinical manifestations may, for example, occur: the antiversa coxa, the valgus knee, the tibial escurvato-varism, the high patella, the osteo-chondrosis as the disease of Osgood Shattler or the Koelher I- II, the cavus-valgus of the foot with Achilles shortness, abduction of the forefoot, the Haglund disease, etc.

The realization of one or the other event depends on which l*ocus minoris resistentiae* is in the limb for acquired genetic or pathological meiopragia (e.g., rickets, dysendocrinisms, neurological disorders, post-trauma damage, etc.) bearing in mind that the biomechanical remodeling, induced by the load,

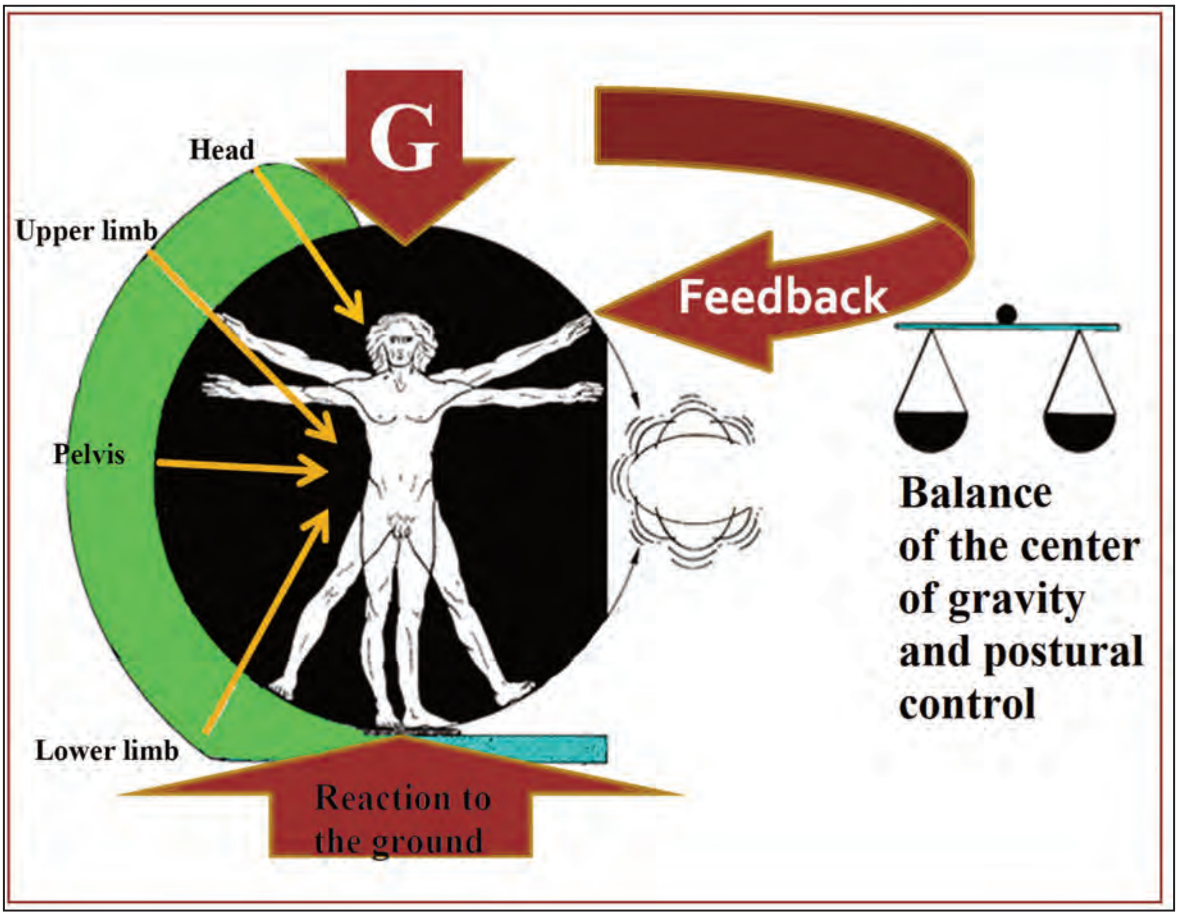

Figure 8. The Load Transmission System (LTS) includes all the structures of the body responsible for the transmission and mechanical use of the load. The activity of the system starts in the foot-ground contact with the s.c. support reaction. This generates the "load" (analogous of the engineering "effort"), which can be defined as "the force exerted by the body of mass (m) subjected to the acceleration of gravity (G) on the plantar surface (S). Namely: Load = mG/S.

tends to concentrate on the still open growth epiphyses and on the entheses of the most stressed tendons.

Particularly in the lower limb, if the static pronation, after adolescence and/or in the adult, persists in the foot and it is no longer possible to resort to other adaptations, deforming processes can be congenital: over segmental, with possible evolution towards osteoarthritis, mainly in the hip and/or in the knee, but especially in the foot that can flatten or spread in the s.c. Triangular Forefoot and concomitant Hallux Valgus Syndrome, etc. (Fig. 10).

The Comparative (Goethian) Onto-Philo-Morfo-Genesis of the appendicular skeleton

We consider that in the embryo the mesenchymal blastema of the limbs is self-differentiating, namely, determined exclusively by the fluent local input of the Genetic information, only at the beginning and until the cartilaginous arcuale is formed. The maturation in the bone is, instead, subsequently triggered, mainly, by external mechanical inputs, coming from the placental environment, already in the 2nd month of pregnancy, with intrauterine movements. Then extrauterines continue even after birth, increasing with the motor activities of the child and adolescent, until the complete skeletal maturation of the adult.

In local development, two spatio-temporal phases are scanned which, following Haeckel's biogenetic law, summarize the phylogenetic process of transformation of the Cordiate extroflexions into “fins” of Pisces: the first proximal-distal gradient for which proximal structures they are formed before the distal ones (e.g., the shoulder develops before the hand); the second gradient is cranio-caudal and the upper limb appears, differentiates and matures before the lower limb (with a gap of 24 h).

In the maternal uterus, the limbs originate towards the 2nd-3rd week from the creation of the zygote, from the end of two pinniform ridges, which recall those of the ultra-remote fish ancestors, decurrent on the sides of the embryo: the Wolff’s crest (Montalenti, 1981). These are made up of mesenchyme covered by ectoderm with mesodermal elements coming from dermomiotones.

The skin and the nerves are composed from the ectoderm and the dermatome, the skeleton, joints, ligaments, tendons and vessels from the mesenchyme while the muscles from myotomas. It is the mesenchymal cells that induce the development and maintenance of the ridge which in turn reciprocates by inducing the ability to form the future skeletal sketches of the limbs with its ectodermal apical margin.

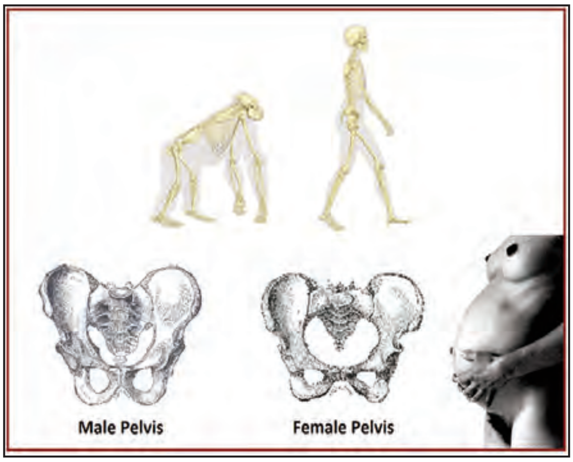

Figure 9. The dimorphism of the woman pelvis derives from the natural selection that on the female body has favored in the first place the gestation, as a function linked to the survival of the human species.

At birth, the upper limbs are longer than the lower limbs, reproposing, in this way, the arrangement of the ape-like progenitors. This gap, however, is filled during childhood and overturned at the end of adolescence, retracing the change in body proportions required by the uptake of the standing station in phylogeny.

Upper and lower limbs are very similar in the early stages of development, due to the identical Goethean morphotypic matrix. Indeed, it can be verified that the longitudinal development of the limb derives from the serial segmentation of a prototype: the *Archipterigium*, consisting of a more or less branched row of bones, which are formally identical replicas of the same original element.

In this regard, it is essential to specify that the realization of the limb is not an appositive growth, like the growth of a hair, but a metamorphic becoming of a unit, always the same, that simply expresses - by implementing itself, in structures of progressive complication - its power. Namely, what it has learned to be in phylogeny, i.e., to adapt itself to survive in the environments crossed. In fact, progressively implementing, in that initial structural unit, a sum of complementary acquisitions (functions) to all those environments.

In this sense, the Morphogenesis of a given anatomical structure in an animal represents nothing more than the video-historic-graphic recapitulation of the particular Genome/Environment relationship exhibited in the succession of its ancestors, until its birth.

Another aspect is that the serial development of the bones is accompanied to that of the muscles and their tendons. Each of these elements is self-constituted to reach and/or aggregate in the final destination.

All together these elements exist as potentialities in pregnancy in Somites and, together, they are realized at birth.

For example, if we consider the development of the muscle-tendon structures of the hand (or foot) and the corresponding insertions in different bones, we find that each partition (longitudinal or transverse) of the skeletal mesenchymal sketch involves analogous partitions in muscular sketches, and associated tendons, and so on in branched succession. Hence the fact that, in the segmental extension of the limb, distal bones are formed distally with attached long tendons that refer to more proximal muscles, similarly originated and mutually differentiated, but all formally identical.

Thus, in the 5th week both Wolff's crests head caudally (to recal the fin evolution towards the amphibious limb of the Crossopterigi of the Devonian) while the apex of each crest dilates in the form of a laminar spatula, *lamina Manus* and *lamina Pedis*, respectively, projecting out, almost at right angles to the body, to recall the amphibious webbed paw (Fig. 11). In the 6th week, these excrescences bend, in the elbow and in the knee, projecting each lamina forward, with the result that the palms of the hands and

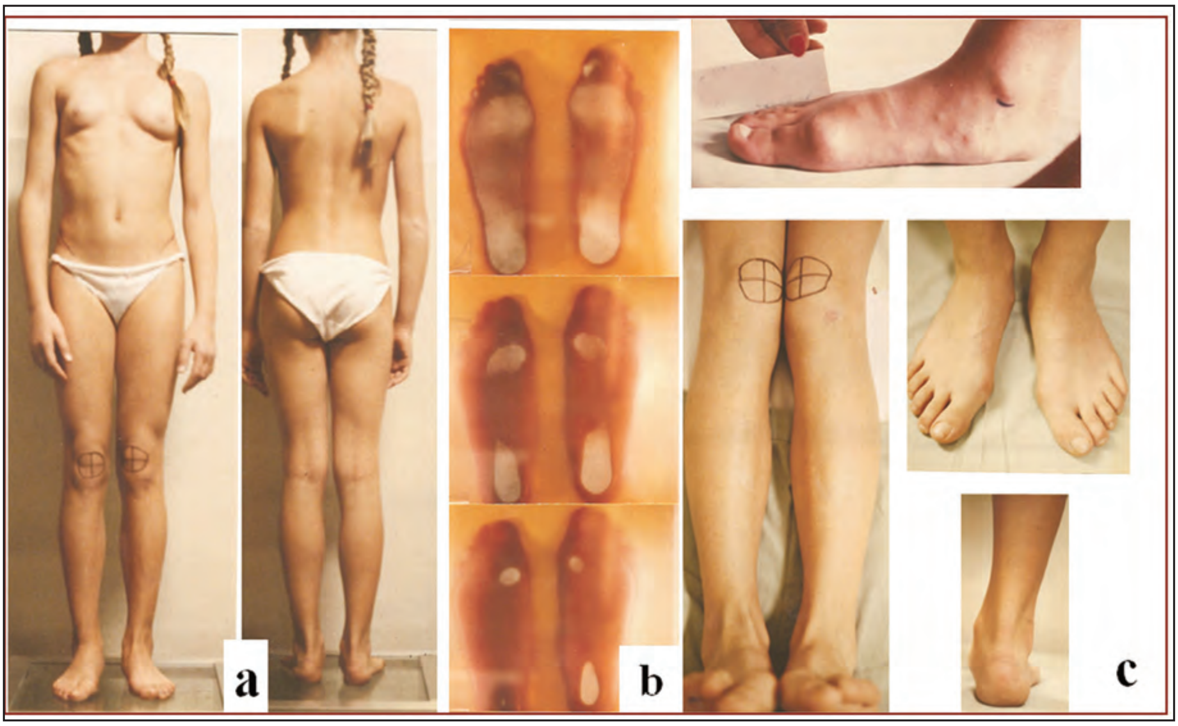

Figure 10. Influence of the Load Transmission System (LTS) on the Morpho-phenotype in a 12-year-old pre-pubescent girl:
a) In this subject, with "valgus calcaneal" arrangement - namely: "insufficient sub-astragalic migration of the calcaneum" - the lopsided input of the load forces the limb into intra-torsion and convergent strabismus of the rotules in the knees, with relative anteversion of the hips. Consequently, the forward bascullation of the pelvis and lumbar lordosis are produced to avoid sub-luxation of the femoral heads.
b) At the podoscope is evident the load at the midfoot, with static pronation. Namely, the load is pathologically medialized on the first ray of the foot to evoke the "ancestral prehensility" of the big toe.
c) In detail, the aforementioned LTS system dysfunction is "spread" throughout the entire limb, with anomalous stresses acting on the more yielding structure. In this case, the systemic adaptation is unleashed especially in the "static pronation" - with disruptive action on the forefoot forced to spread in the metatarsal fan - and relative more or less slow "appearance" of valgus of the big toe.

the soles of the feet are arranged parallel to the trunk, to recall the progressive evolution of the amphibian-terricolous limb, during the Carboniferous (Fig. 12). In the 7th week the limbs undergo a 90° twist on their longitudinal axis, but in opposite directions. Thus the elbows position themselves caudally and the knees cranially, to recall the course of the terrestrial reptiles, during the Permian (Fig. 13).

Some particular aspects of this development are to be emphasized, as they retrace phylogeny and are reinterpreted in the pathology, as in previous situations, will be useful to the best consideration of these phenomena.

In the upper limb, the scapula migrates caudally from an initial cervical position, like in fossil fish. The cleithrum, a membranous structure which unites the scapula to the skull in the amphibians, is lost. At the same time, the scapula widens with increasing relative dimensions of the suprascapular fossa to recall the transition from the reptiles-terrestrial mammals to the terapsids and then to the arboreal primates. The acromion widens, recalling the brachiation of the Primates, assuming at birth various morphologies, which then mature in the adolescent, according to the specific motor activity of the subject. The coracoid also progressively widens to recall the assumption of the standing station.

The humerus appears during the 7th week between C5-D1 penetrating, like a finger in the glove, the brachial sketch. At the same time, the anti-torsion of the proximal head and the external torsion of the distal blade occur. During the 8th week periosteal bone is deposited in the diaphyseal body, where a nutritious vessel penetrates, thus, by clinical convention, marking the end of the embryonic period.

Then, during the 5 week the forearm skeleton appears by longitudinal partition of a single mesenchymal mass detached from the humerus when the elbow is formed and differentiating 2 bones: the radius and the ulna. The ulnar sketch is larger than the radial one and distally continues in the carpus; subsequently these relationships (which reproduce the original crossopteric structure) change; so that the development of the radio over the ulnar sketch forces the latter to plicate transversely in the carpus and, while from their mutual contact will derive the radio-carpal joint sketch, the meniscal structure - analogous of the radio-carpal meniscus present in the Reptilian mono-articular carpus with a unique row - is reproposed.

In the same period, the radio-ulnar mesenchyme (prolonged in Lamina Manus as the only medial outflow) is subdivided into three segments (to recall the tridactyl hand of the Jurassic reptiles) and then in the five of the pentadattile prototype, for further subdivision (Fig. 14).

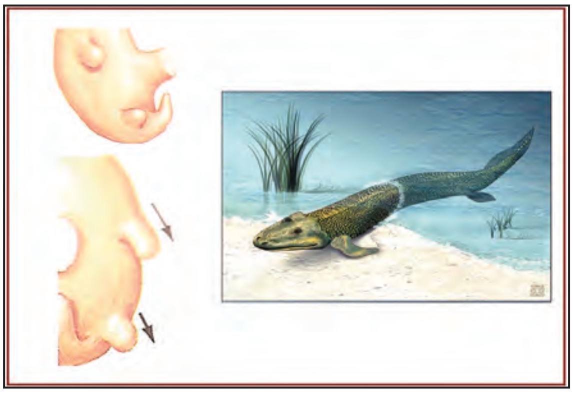

Figure 11. Onto-philo-morphogenetic comparation of the limbs: 5th week from the establishment of the zygote.

Figure 12. Onto-philo-morphogenetic comparation of the limbs: 6th week from the establishment of the zygote.

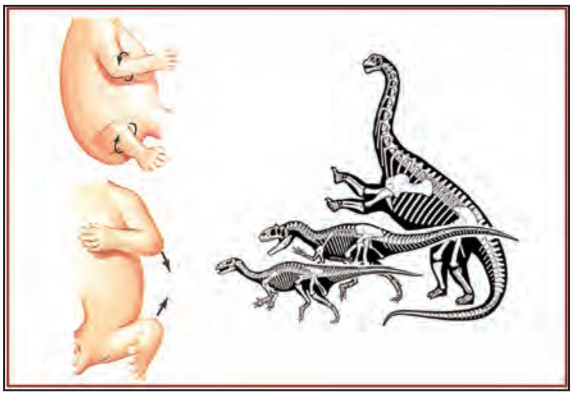

Figure 13. Onto-philo-morphogenetic comparation of the limbs: 7th week from the establishment of the zygote.

It is important to underline that even in this period the carpal area is undifferentiated. In fact, the appearance of bone sketches occurs in the 7th week at the same time as the aforementioned transverse plication of the mesenchyme: therefore, the distal portion differentiates a phylogenetically older part (reptilian): the *Paleo-Carpus* which includes the capitate-hamate pair and the midcarpal joint; and a more recent proximal portion: the *Neo-Carpus* which includes the first carpal row and the radio-carpal joint. In other words, the typical biarticular-double-row carpus of Primates is structured, whose relatively late definition will be completed, long after birth, after adolescence (Grippi, 2016) (Fig. 15).

In fact, ossification begins in the capitate and in the hamate (6 months - 1 year) followed by the radial epiphysis (2 years). The carpal condyle (the first carpal row) ossifies last: with triquetrum (3 years), lunate (4 years) and scaphoid (6 years) (Bonola et al., 1981; Tardif et al., 1998; Oztuna et al., 2003). Moreover, personal microscopic observations made on the 13 cm fetus (3.5 months) have shown that in the carpal mesenchyme there is a distal-proximal gradient of articular cavitation; therefore, the medium-carpal joint is, at that age, already completely constituted, while the radio-carpal joint appears to be largely obliterated (Grippi, 2008).

All the aforementioned maturation sequences, in the light of the Biogenetic Law, further highlight the emergence and mechano-evolutionary hierarchy of bones and joints in phylogenetic succession, indicating that the oldest articular district is the middle-carpic district of Coxa Manus, while the carpal row and radio-carpal joint are relatively newer acquisitions, constituted last in the Primate Brachiation (Fig. 16).

In the lower limb, as already mentioned in relative delay with respect to the upper limb (to recall what happened in the transition to the land of crossopterigi fish), the pelvic belt is divided into three bones: ileum, ischium and pubis; converging into the

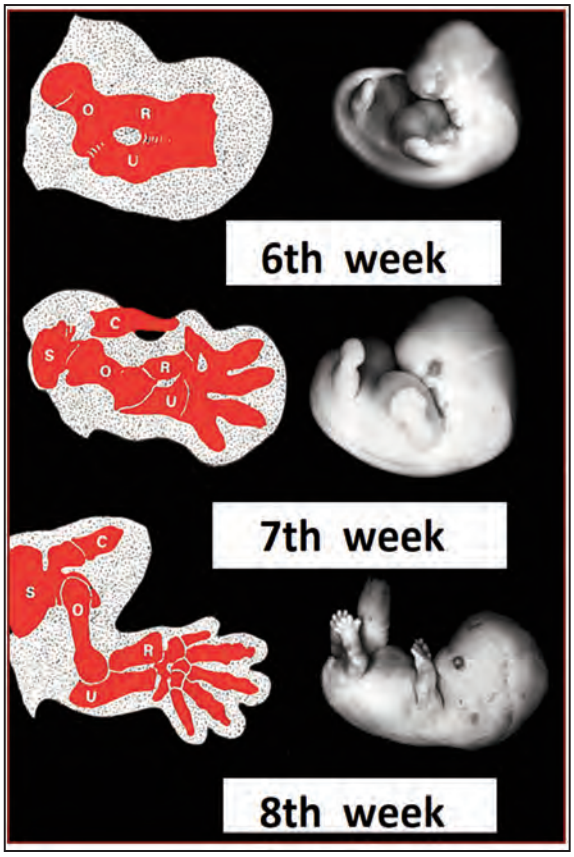

Figure 14. In the upper limb, the scapula migrates caudally from an initial cervical position. The humerus appears at the 7th week between C5-D1. In the 5th week, the forearm appears by longitu-dinal partition of a single mesenchymal mass which then divides into the radio and the ulna. In the same period, the radio-ulnar mesenchyme - prolonged in Lamina Manus as the only medial out-flow - is subdivided into three segments - to recall the tridactyl hand of the Jurassic reptiles - and then into the five of the penta-dattile prototype. Legend: C, clavicle; O, humerus; R, radio; U, ulna.

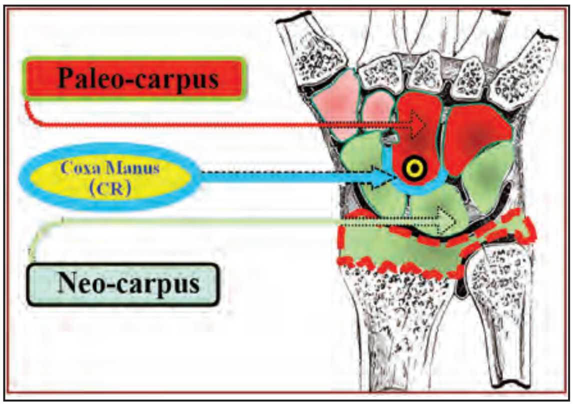

Figure 15. In the carpus, the appearance of bone sketches occurs in the 7th week at the same time as a transverse plication of the mesenchyme. Therefore, the distal portion differentiates a phylogenetically older part (reptilian).
The Paleo-carpus which includes the couple capitate-hamate and the middle carpal joint; and a more recent proximal portion: the Neo-carpus which comprises the first carpal row and the radiocarpal joint. The Coxa Manus will then be structured in the center.

acetabulum that houses the head of the femur. The ileum connects to the sacral vertebrae from which it branches (probably the first to metamorphize from the vertebral processes of the primitive fish, in the constitution of the archipterigius of the anal fins).

The sketch of the femur appears at the 5th week and develops in a proximal-distal direction with the longitudinal axis in internal rotation and in adduction, for which the femoral neck is constituted with angles of inclination-declension initially minor (re-proposition of the terrestrial structure amphibian-reptilian); it is larger, re-proposing the arrangement of arboreal primates, of those that further increased during childhood and will be definitive in the adult (re-proposition of the assumption of the standing station).

In the middle of the 6th week the skeleton of the leg appears by longitudinal partition of a single mesenchymal mass, detached from the femur in the constituting of the knee, and it differs in the 2 bones: the tibia and the fibula, with identical morphology and both articulated to the respective femoral condyles.

Subsequently, the fibula decreases in volume by disarticulating from the femur and migrating to the side; at the same time, the tibia widens and replaces proximally the fibula, relating alone on both femoral condyles. The same happens at the tarsus level.

In fact, distally, the mesenchymus tibio-peroneal, prolonged in Lamina Pedis as the only medial outflow, is subdivided into three segments, to recall the three-fingered foot of the Jurassic reptiles, and then into the five of the pentadattile prototype, for further internal subdivision (Florio, 1966).

Initially, the peroneal sketch is larger than the tibial; subsequently, these relationships, which reproduce the original crossopterygian structure, change. The development of the tibia on the fibula forces the tibia to plicate (transversely into the tarsus), while the tibio-tarsal articular sketch derives from their mutual contact. Practically, the arrangement of the tibio-fibulo-tarsal meniscus of the digitigrade Terapsidia is repeated.

In particular, the two bone sequences, astragalus-scaphoid-cuboid-(1st-2nd cuneiform) - (1st-2nd-3rd ray) and the other: calcaneus - (3rd cuneiform) - (4th-5th ray), derive from the bipartition of the mesenchyme, respectively: in the tibial component, so-called Astragalic Foot, and in the fibular component, so-called Calcaneal Foot (Pisani, 1990). However, the exclusion of the fibula caused by the enlargement of the tibia leads this to cover the talus and the calcaneus, side by side together, to act as a meniscal pulley to the flexors of the foot, which meanwhile lengthens. For this, at the end of the 6th week the foot is in equine, to recall the reptilian digitigrades.

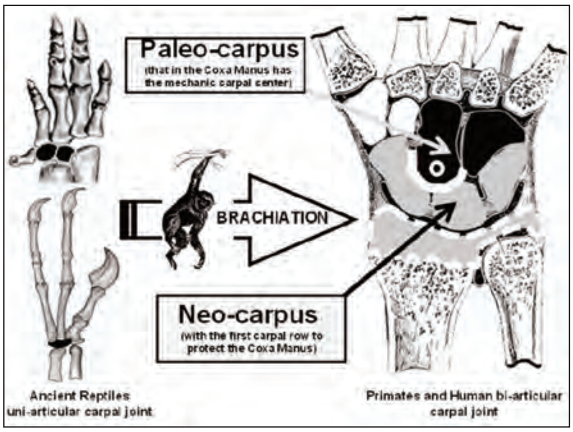

Figure 16. The Human bi-articular carpal joint comes from the reptiles uni-carpal joint, with an ontophilogenetic development for which the radio-carpal joint appears after the mid-carpal joint. So that, in wrist is possible to distinguish two parts: a distal, ancient - the Paleo-Carpus - represented by couple capitate-hamate; the other proximal, recently - the Neo-Carpus - represented by the entire distal carpal row. .

Towards the end of the 7th week, the foot goes in supination for the development of the tuberosity and the subtalar migration of the calcaneus (verticalization of the backfoot), at the same time the five metatarsal-digital rays diverge in a radial pattern (to remember the ascent on the trees and the prehensile structure of the forefoot) (Fig. 17).

Then, during the fetal period, and until birth, the forefoot is twisted into pronation, in the central part stretching more than in the fingers (horizontalization of the forefoot), the metatarsal fan progressively (re)-closes, plantar arches are made up and the attitude in equine-varism recedes. So the return to the ground of the foot happens, abandoning the prehensile attitude and reconfiguring of the elica podalica in an antigravity sense (3).

Still, at birth it is easy to observe the prehensile atavism in the first abducted metatarsal and in the plantar fold between the 1st and 2nd ray, which evoke the ancestral opposition of the big toe to the other fingers.

Then, in the growing baby, the sense-motor development traces the phylogenesis like skeletal maturation, with the appearance of vertebral curves and completion of the anti-gravity ossification. But, in particular in the lower limb and in the foot, the plantar arch is defined and completes the sub-astragalic calcaneal migration, in agreement with the supra-segmentary directives and considered systemic modalities, to optimize the bipedal ambulation (Fig. 18).

In this regard, it should be recognized to Paparella Treccia (1977) the intuition that in the temporal phases of walking , the lower limb recalls its phylogeny.

This is a further systemic manifestation of the Goethian cycle of expansion (diastole) and contraction (systole) alternating. In fact, walking is included between the two calcareous supports of the same foot and is constituted by a supporting and an oscillating phase:

a) calcaneus receiving contact; the limb and the foot are contracted in equine to recall the crossopterygian fin that pushes towards the ground.

b) total contact support; the foot expands to receive the gravity input of the load as a memory of the amphibian-reptilian plantigrade.

c) digital support and push; the foot (re)-contracts, from the heel, in rapid segmental succession the direction of the fingers, renewing the movements of the Crossopterygii, then of the equine reptile and, finally, the propulsive prehensile one of the arboreal tetrapod.

In the oscillating phase, then, the body releases (re)-expanding in controlled gravity towards a deliberate direction of travel. The fall is stopped by the contralateral limb in a new support phase and so on, cyclically.

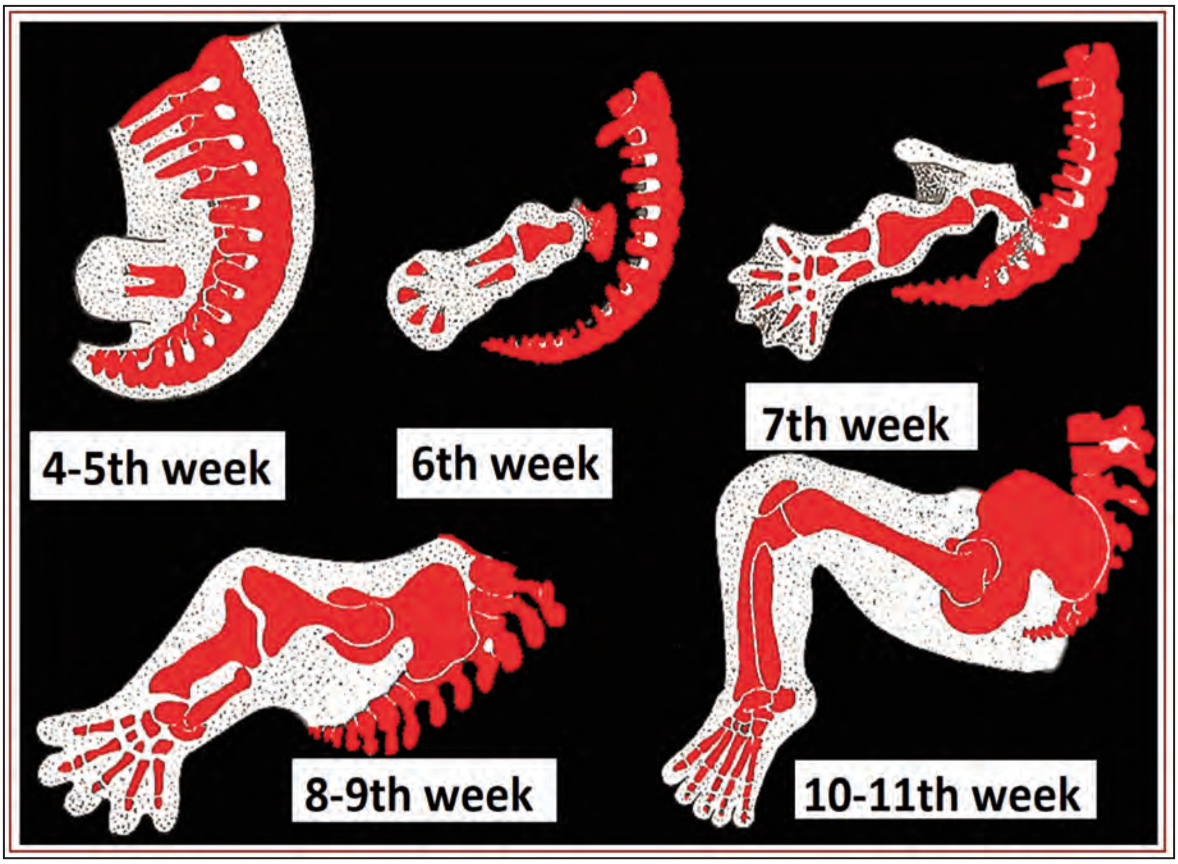

Figure 17. In the lower limb, the femur appears in the 5th week. In the middle of the 6th week, tibia and fibula appear. Distally, the Lamina Pedis is divided into three segments, to recall the three-fingered foot of the Jurassic reptiles. Towards the end of the 7th week the foot, supine for the development of the tuberosity and the subtalar migration of the calcaneus (verticalization of the back-foot), the 5 metatarsal-digital rays diverge in a radial pattern at the same time (ascent on the trees is recalled and prehensile structuring of the forefoot). Then, from the 8th - 11th week onwards, the forefoot is twisted in pronation, the metatarsal fan progressively recloses, the arches are plantar and the attitude in equino-varism recedes. Namely, there is a return to the ground of the foot, with abandonment of prehensile attitude and reconfiguration of the Elica Podalica (Paparella Treccia, 1977) in an anti-gravity sense.

THE PATO-MECHANICAL STRUCTURE ACCORDING TO THE REGRESSION PRINCIPLE

For a better understanding of the topic we are examining, we present some key concepts of Systemic Cybernetics, previously mentioned:

1) living beings are a condensation of information and all the phenomena that concern them are

identified with the transformation processes of their informative content;

2) the cybernetic system includes the concepts of input, output, feedback, homeostasis, functional reserve, etc., because the increase in information content (neghentropy) of eco-system - in support of the law of Haeckel - corresponds to the phylogeny recapitulated in the Onthogenesis;

3) all living beings are open systems. Namely, they receive and release inputs from and to the outside, made by "n" hierarchical microsystems in which every function performed is an output that identifies a structured sub-system in an anatomical organ or complex. Systemic behavior is governed by identical principles in each sub-component, based on the general isomorphism;

4) in the body, the reaction to any abnormal environmental inputs (pathogenic noxa), is an adaptation that takes place according to the Regression principle, so: "*any systemic destabilization involves the re-emergence of functional activities and/or structural crossed in the philo-onto-morphogenesis*";

5) in the "Movement Organs and the locomotor System" it is possible to identify a systemic hierarchy that includes the two cybernetic systems of this study: a) Architectural Maintenance and Trophy System (AMTS), b) Load Transmission System (LTS) (of the Human body) (see description on page 26 and following).

Architectural Maintenance and Trophy System (AMTS) and Load Transmission System (LTS) (of the Human body)

We reiterate that, in respect of the epigenetics, the activity of the AMTS in the structuring of the Morphotype is realized by the complementary competition between the genetic information of the DNA and the environmental information, mainly mechanical inputs, coming from the LTS. Namely, in the course of existence, the conformation of the limbs does not represent the free expression of the genotype but what the environment has induced to express, as a phenotype. Namely: *Genome + environment = Morphotype*. It follows that, due to the exclusive effect of genetic instruction, the organism would produce dysmorphism if the structures were not shaped by the environment. With regard to the

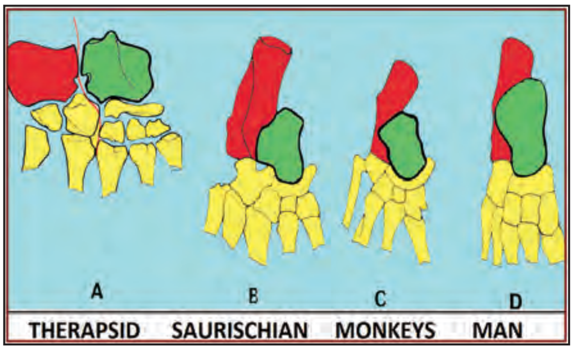

Figure 18. The sub-astragalic trip of the calcaneus is reproduced during the Phylogeny and it is summarized in onto-genesis and continues until birth in the developmental age (s.c. verticalization of the back foot).

tenso-mechanical input, it is known, for example that the shape of the acromion, the trophism of the arms and legs, the detorsion of the femur and/or of the talus etc., are produced by ligamentous and muscular factors that act with motor activity. Similarly, the environment (especially in the lower limb) by means of mechanical load stresses can favor the development of dysmorphism if the structures are not genetically resistant or if they are weakened by intercurrent pathological events. Namely, the typical relationship: *Genome + environment = Morphotype* would become: *Genome (abnormal) + environment (normal)* or, otherwise *Genome (normal) + environment (disturbed) = Dismorphism*.

In detail:

1) *in the genetic component*, dysmorphism can be produced both by local anomalous inputs and by systemic input. In the lower limb, for example, anomalous supra-segmental structures, capable of permanently modifying the load transmission, may condition the dysmorphic change in normal feet. Similarly, the opposite is also possible; congenital alterations of the foot (malformations) condition adaptive dysmorphisms in normal supramegmentary districts.

2) *in the environmental component*, the effects of the tenso-mechanical anomalies are different in developmental age or after puberty; they also condition the individual in growth (auxological factor).

Specifically:

A) *in the growing subject*, anomalies in the load transmission involve the use at the various systemic levels of the adaptations of the functional reserve. In particular, the AMTS is induced to remodel structures by exploiting their residual growth.

Thus, if the correspondence between anatomy and function is lost, within certain limits the local genetic expressivity may change. The whole systemic hierarchy is involved in this task and the adaptive rebalancing is still possible.

Relatively to the lower limb, this is sometimes expressed with clinically indefinable morphological structures (*evolutionary Deformities*): not properly normal but not even frankly pathological (borderline para-dysmorphism). In these cases, however, the resulting morphotype is the best adaptive compromise and, in homeostatic terms, the simplest expressed by the systemic hierarchy.

B) *in the subject who is completing or has completed the growth*, in the event of load anomalies it is no longer possible to resort to remodeling the structures.

With the end of somatic development this is prevented. If further adaptations are necessary, because those of growth have been insufficient or have become so due to the appearance of new stresses (e.g., weight gain, pregnancy, sports activities, etc.), these can be made with local trophic adjustments that exploit the physiological metabolic turnover (e.g., bone apposition and remodeling, muscle hypertrophy, etc.).

With these processes, over time, the macroscopic aspect of the most stressed structures can change, but so slowly that they are not very effective, and more resolutive and non-physiologic (adaptive) phenomena can occur. These imply that, in the presence of abnormal and persistent loading stresses, the weaker structure of the systemic complex ends up collapsing. The collapse is greater the weaker the segment concerned is or due to the genetic meiopragia or because it is compromised by degenerative, phlogistic or post-traumatic processes or by natural senescence.

Especially in the foot (but also in the wrist and hand with rheumatoid inflammation, etc.) can thus be explained the appearance of dysmorphia in adulthood (*Involutive Deformity*) caused by the collapse of the structure: so-called *architectural collapse*. In these cases it is the mechanical stress, rather than the basic pathology, to initiate and sustain the dysmorphic evolution.

The systemic classification of the Dismorphies

Following the above concepts, the Dismorphies can be classified into two classes: congenital and acquired (Grippi, 1986) (Fig. 19). They can be aggregated into three groups: malformations, evolutionary deformities and involutive deformities, classified as follows:

A) *Chronological*. Referred to the life of the individual (in the embryo-fetogenesis, after the birth and in the developmental age, in the adult);

B) *Functional*. Referring to the qualitative and quantitative presence of environmental inputs, tensile-mechanical stresses, on the structure. These stresses, generally, increasing with the beginning of motor and walking activities, are proportional to the activities carried out;

C) *Informational etiology*. Referred to the causal role played by the informational inputs in the genetic or environmental component.

The three groups present different clinical characteristics, respectively:

1) Malformations are dismorphies present at birth (congenital) or in early infancy independent of motor activity and due, almost exclusively, to anomalies of genetic information except those rare cases induced by environmental exogenous factors of a mechanical nature, which acted, within the maternal womb, on the product of conception (oligohydramnios, twinning, position vices, etc.). Generally, genome damage is however secondary to environmental inputs that have acted on the germ cells of the parents or, even before, in the progenitors of these with mutations in the DNA or even on the product of the conception (drugs, infections, toxic substances, radiation, etc.).

What qualifies the malformations is the permanent and potentially transmissible damage of the genome, which alone manifests the tendency to self-maintenance throughout life.

Malformations may occur in the context of systemic dysmorphic syndromes (e.g., Marfan disease, arthrogryposis, Down syndrome, etc.) or involve only a defined anatomical structure with varying degrees of impairment according to the expressivity of the morph-genetic program.

Classical examples of malformations are, in the Hand and in the Foot respectively: the Madelung and the congenital twisted foot, in their multiple clinical aspects.

2) The "Evolutive Deformities" (almost exclusive of the lower limb) are dysmorphies not present at birth, beginning in the developmental age and influenced by motor activity and load on the limbs. In these deformities, the etiological mixture between the genetic factor and the environmental factor can be relatively variable.

For deformity to develop the presence of an abnormal low systemic penetrance gene (meiopragic genome) is necessary, whose phenotypic expressivity may be normal for most of the growth. This anomaly, added to the trophic-mechanical effects of the load, at a given moment of growth, reveal and make the deformity clinically evident as if it had been induced by it. In reality, without the environmental impact, the deformity would probably never have occurred.

Depending on the degree of genetic impairment and the amount of mechanical stress, the onset of the disease can be more or less precocious, with a variable evolutionary tendency and with a different clinical expression depending on the individual's history (diet, growth modalities, sports activities, preferences in choosing footwear, etc.).

The deformity can even remain latent or manifest in sub-clinical variants and its full development can occur, at a later time, in the adult or in the elderly to a greater extent if local degenerative or phlogistic processes are associated.

These diseases represent the link between the congenital dysmorphia and the acquired ones. Often, in the individual case it is very difficult to resolve the actual causal role played by the genetic factor and the environmental factor. This group includes a large part of the flat feet and the valgus toes.

The action of the load is necessary for the pathological manifestation and their clinical reference is in the pathology of altered load or in that antigravity insufficiency of the foot which was mentioned by PAPARELLA TRECCIA (1977).

3) The "*Involutive Deformities*" in the lower limb are acquired dysmorphies that occur in the adult (after the end of growth). The environmental input of the load is the cause.

These pathologies include some dysmorphia of the previous group, which continue to worsen in adulthood. In all cases, their clinical course is marked by the (more or less slow) *architectural collapse of the anatomy*.

They can be considered belonging to this group: the deformities of the rheumatoid foot, the evolutionary sequelae of the Hallux Valgus (HV) in the elderly, the flat foot of the marathon runner, the valgus foot of the tennis player, etc.

The aforementioned systemic classification of dysmorphia is a valid theoretical tool with which to understand pragmatically all the congenital and/or acquired forms but, in the clinical concreteness, "*cum grano salis*" must be used. In fact, it is not possible to place absolute distinctions. In addition, elements acquired during adulthood can be added

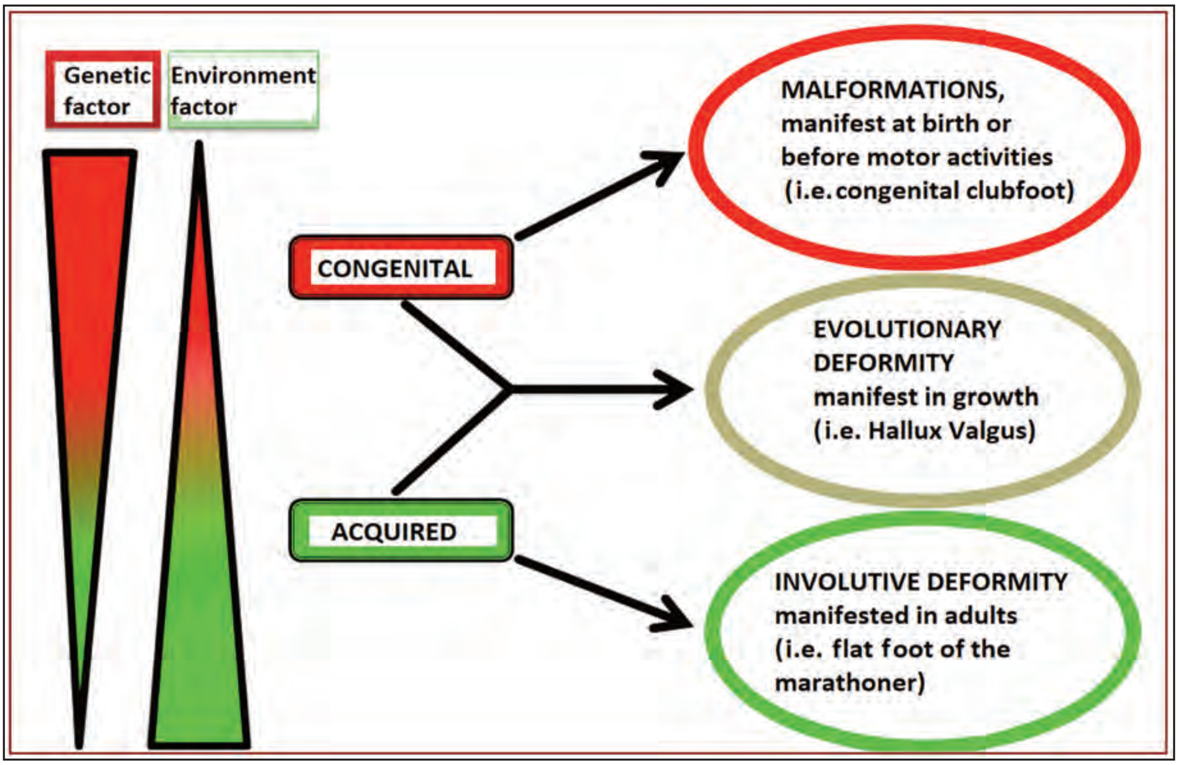

Figure 19. Foot Dysmorphies can be classified into two classes, congenital and acquired; aggregated into three groups, Malformations, Evolutionary Deformities and Involutive Deformities.

to an exclusively congenital pathology in childhood, and/or viceversa. Indeed, it is enough to consider the Congenital Twisted Foot: the dysmorphia is certainly determined by an anomaly of the genome but its evolution in the walking child is conditioned by the function; the clinical aspect of the pathologic foot at birth is very different from that of the untreated adult.

In general, the causal role played by the genetic factor is at its maximum in malformations, intermediate in the evolutionary deformities, to its minimum in the involutive deformities. The opposite happens for the causal role played by the environmental factor.

For further exemplification: the Hallux Valgus (HV) present at birth or in early infancy is a malformation due to genetic factor. If it manifests itself during growth it is an evolutionary deformity and, in this case, the effect of the load or the modeling of the footwear may have accumulated with the predisposing unexpressed genetic factor; an HV of the first two groups which tends to worsen or that appeared after the growth is an involutional deformity due to the load, with the possible concurrence of local degenerative or phlogistic processes.

Similarly, the flat foot is a malformation, an evolutionary deformity or an involutional deformity that manifesting itself, at birth, during growth, or in the adult, respectively.

Further, we reiterate that in the biological structure any dysmorphic event can be related to an informational disorder that interests, individually or variably, the genetic and/or environmental side. These clinical manifestations of onset and evolution depend both on the specific place of the systemic hierarchy in which noxa converges, both from the moment and from the modalities with which, during individual existence, the dynamic equilibrium between genes and the environment in structuring and maintaining the Morphotype is broken.

From the Regression Principle to the "Dysmorphogenetic Law" (foot application)

We let us state that what is now discussed, although generalized to the whole skeleton, takes on a marked clinical relevance only in the foot as a consequence of its antigravity mechanics. For exemplification, therefore, we will make exclusive reference to this.

In fact, with clinical observation it is possible to note that the dysmorphism of the foot tends to occur with relatively stereotypical elementary components which refer to analogous anatomical-functional attitudes present in the foot during onto-morphogenesis and, therefore, in phylogeny, such as: calcaneal valgus, metatarsal supination or adduction, equinism (diffuse, or segmental), flatness, fan-like enlargement of the fingers, valgus of the big toe, claws of the fingers, etc. In general, the solitary, multiple or variously associated presence of these pathologies in specific clinical patterns allows the recognition and the nosographic classification of the various Dysmorphies.

But this circumstance is not casual, if anything implies that, regardless of the etiology, be it genetic and/or environmental, the dysmorphic event is a manifestation of the principle of Regression in its profound pathogenetic aspects.

To verify this assumption, we can compare the fundamental steps of the ontomorphogenesis of the foot and the phylogenetic correspondences with the destructuring phenomena that occur in the Architectural Maintenance and Trophy System (AMTS) during the development of the evolutionary and involutive deformities of the foot. Some of these aspects are present in the flat foot, others in the hallux valgus, others in intermediate syndromes such as the splay foot or the synostotic foot, etc.

With regard to malformations, as in congenital clubfoot, we must remember the hypothesis proposed by BOHM (1930, 1935) that, referring to the theory of *vitium primae formationis* (dating back to the Middle Ages), argued that this deviation from the normal development process consists in an arrest or germinative inhibition, Hemmungs-Bildung of Germans Authors, for which specific skeletal characteristics of a specific phase of embryogenesis remain.

This point of view is well linked to the Regression principle in the sense that the malformation can actually be considered as an architectural arrangement of the foot with less information content than the norm. Therefore, the malformed foot, already at birth, it has a regressive morphology that recalls that specific phase of embryogenesis in which it remained inhibited. In this sense, for example, tarsal synostoses are to be interpreted that recall the structure of phylogeny in which the partition between the astragalus and the calcaneus was absent (as in *Syntarsus* reptiles, hence the name of molten tarsus).

The dysmorphic event, therefore, independently from the specific efficient cause, seems to be supported and regulated by a common denominator: the architectural regression towards structural elements with less information content. We have framed the dysmorphies in three clinical groups with main differences.

In the Malformations, compared to the normality standard, regression is only apparent as dependent not on the turn around but on a local arrest caused by a genetic abnormality.

In the evolutionary Deformities the subject is normal at birth, then with the beginning of motor activities and during the developmental age, due to the relative genetic inadequacy with respect to the biomechanical needs, the architectural regression slowly manifests itself confused with the same process of growth which in the meantime tends to regulate and minimize it.

Instead, in the Involutive Deformities, the architectural regression is supported almost exclusively by the tenso-mechanical load factor, with onset after the end of growth in adult age, with occasional progressive episodes or, more rarely, with rapid onset and evolution clinic towards the architectural collapse of the involved part.

This phenomena are at the base the Dismorphic phenomenon and represents the costant way in which they take place; so, by virtue of system isomorphism, it has a general value.

In other words, the becoming meta-(dis)-morphism is regulated by a regressive rule that can be stated in the form of "Dismorfogenetic Law" (DL), namely: "*The dysmorphic event reproduces backwards functional and structural arrangements that recall those present in the phylogeny, and recapitulated in the onto-morpho-genesis*" (Fig. 20).

The DL can be easily verified in the foot with examples taken from the clinic. In particular, in the evolutionary and involutive deformities. Starting from normal structures, morpho-functional aspects progressively acquired are achieved, recalling in reverse ontogenesis.

We report previously didactic cases: on the malformations, the evolutionary deformities, the involutive deformities.

However, the best exemplification is in the various ethio-pato-genesis of the Hallux Valgus (HV) syndrome, up to the establishment of the so-called Triangular forefoot, which actually expresses the entire clinic of the three dysmorphic groups.

In fact, among the pathogenic noxae (etiological causes) of the HV, we consider:

1) Supra-segmental factors in the foot represented, for the most part, by auxological factors, by anomalies of the detorsional process of the lower limbs and, in women, the particular arrangement of the pelvis.

2) local factors of the foot represented by bone or joint or ligament anomalies, etc., concerning the first ray and conditioning, due to the insistence of a cavus-valgism from the shortness of the Achilles tendon, of the static pronation arrangement of the forefoot persistent at the end of development and in the adult.

If the sum of local and suprasegmental concauses exceeds a certain critical value, the progressive appearance of the AV would be a secondary phenomenon to the plastic collapse until the demolition of the foot's architecture. In this sense, the deformity would be an adaptation process that involves the whole body supporting and walking system (the Load Transmission System). Regarding the pathogenesis, this deformity would be due to the adaptive regression of the systemic hierarchy operating locally according to the Dismorfogenetic Law.

In fact, in the ideal clinical evolution of the deformity, we can observe the progressive appearance of acquired morpho-functional aspects of the foot that recall analogous arrangements of phylogenetic evolution and of onto-morphogenesis.

Among these, we have the functional prehensility of the first ray (corresponding to the static pronation), the enlargement of the metatarsal fan (in particular, the misalignment and supination of the first metatarsal), the plantigrade, etc. (Fig. 20).

This law does not mean that the structure of the foot really go backwards. The return is merely recalled but does not take place (Florio, 1965).

Next, in exposing the Systemic Surgery of the Foot, we will see what are the practical applications derived.

The Dismorfogenetic Law (application in the Hand): Malformations and deformities of the "Adaptive Carpus"

Unlike the lower limb, in the upper limb the antigravity load input has a relatively negligible trophic role; viceversa, a relevant input is that derived from manual activities, which (to a further difference) never lead to dysmorphic situations (except in rare cases of work Over-Use, in children).

Namely, in the equation: Genome + Environment = Morphotype (of the upper limb), the morphosant role played by genetic information is prevalent; limiting the environment to the generic modulation of tissue trophism: e.g., in conforming the muscles according to the quality of the work (as would happen in a pair of monochorionic twins, of which the first is a farmer and the second is a pianist). Consequently, most of the dysmorphic features of the upper limb are already present at birth (congenital) and contextualized in the area of Malformations.

There is, however, a minimal remnant of non-congenital dysmorphies, but acquired, resulting in eventual degenerative or post-traumatic damage.

In particular in the wrist, fractures and ligament injuries tend to be achieved with peculiar dysmorphic aspects (malunion and bone malalignment) and variable changes in the kinematics (so-called Carpal Instability). However, it is also possible that despite

Figure 20. The three prototypes of the anatomo-pathological expressiveness of the Dismorfogenetic Law applied to the foot.

these severe outcomes, the function remains acceptable, still useful for a long time.

This situation corresponds to the s.c. Adaptive Carpus with "*compensatory modifications of the intracarpal bone relations ... of the distribution of the pressures and premature wear of the cartilaginous surfaces* ...". Or, as post-fracturing midcarpal instability (Adaptive Carpus or Pseudo Carpal Instability), consisting of an abnormal kinematic response to the bad healing of a fracture.

Well, it can be seen that these acquired dysmorphic situations of the carpus (Malformations and adaptive instability) follow the Dismorfogenetic Law, according to the Regression Principle (Grippi, 2008).

The Biarticular Concentric Carpal Mechanics and the "regressive" patho-mechanics of the carpus

To go into the details, it is necessary to sum up the physiology of the wrist with the concepts of the Biarticular Concentric Carpal Mechanics (BCCM) (Grippi, 1997):

1) The carpus is designed as a biarticular femoral prosthesis in which the prosthetic head is reproduced by the the capitates head; which, on the scaphoid-lunate concave articular side (so-called Cotile Manus), constitutes the enartrosic articulation of Coxa Manus (CM).

2) In the radio-carpic movement, the carpal condyle undergoes twisting with focus on the capitate's head; in the same point, the axis of the radio and the axis of the hand converge to constitute the Center of Rotation (CR) of the Coxa Manus (CM) (and of the whole carpus). Maintaining this situation is the categorical imperative of carpal stability.

3) CM disconnection implies radiocarpic-axis/hand-axis divergence and defines the anatomo-pathological dysfunction of Carpal Instability.

4) In Phylogenesis, the two-row biarticular carpus of Man derives from the single-articular one-row carpus of the Terapsida and Teropodi reptiles.

5) In the carpus it is possible to distinguish two transverse segments, from the differentiated ontogeny: distally an older part, the Paleo-carpus represented by the capitate-hamate couple, including the mid-carpal joint; proximally a more recent part: the Neo-carpus represented by the first carpal row, including the radio-carpal joint, which, during evolution, overlapped the first to refine the grip and at the same time protect the integrity of Coxa Manus (Grippi, 2008, 2016).

Expression of the Regression Principle in the Pato-mechanics of the Adaptive Carpus

From the fact that the carpal architecture is a consequence of the phylogenetic process - for which anatomy concretizes the morphogenetic stratification of the same past - it is easy to understand how the lesional damage can express itself with anatomopathological structures that evoke stages of the same process "in reverse", according to the Regression

Figure 21. Examples of the Hallux Valgus and Plantar Flatness where the dysmorphic event reproduces "in reverse" functional and/or structural arrangements that recall those present in phylogeny, and summarized in ontogenesis: a) 16 year old girl: the modest patellar strabismus of the knees is symptomatic of the incomplete femoral detorsion, the foot is cavus-valgus in static pronation; b) in the right forefoot, the spread of the metatarsal fan is incipient, the "exostosis bursitis" has appeared and the big toe starts to assess; c) at the podoscope, the anomalous medialization of the load on the first metatarsal in the biped-station; d) same subject 18 months later: the "exostosic bursitis" also appeared on the left foot, the plantar vault collapsed; e) the metatarsal begins to deform in supination (reenactment of plantigrade of amphibians and reptiles); f) the normal podoscope shows a typical flat foot; g) Radiography of an adult's foot with a triangular forefoot, notably the widening of the metatarsal fan; h) another elderly patient with a triangular forefoot evolved only on one side; i) in another elderly patient, the forefoot is completely spread out and the big toe is undercover, to recall its ancestral prehensility, all other fingers are subluxated and in claws.

Principle and the Dismorfogenetic Law, already discussed.

Therefore, "the dysmorphies reproduces - backwards - functional and/or structural arrangements that recall those crossed in phylogeny, and summarized in the onto-morpho-genesis"

In particular, in the wrist, the mechanical set-up of malformations, and acquired dysmorphism (traumatic and/or degenerative), even with severe radiocarpic damage, tends spontaneously to maintain an acceptable function. As already mentioned, this patomechanical situation corresponds to the s.c. Adaptive Carpus.

From the two-row biarticular structure of the human carpus derives its functional versatility and redundant adaptive capacity in the consequences of fractures and in congenital or acquired dysmorphism, such as Madelung, Kienböck's and SNAC-SLAC-SCAC wrist, etc. This adaptation - which basically consists in the privileged use of Coxa Manus when some damage is present that stiffens the radio-carpal joint - accounts for the possible good outcome after malunion fractures of the radius and/or the occasional benign evolution of the dysmorphic carpus, and corresponds to the interdiction of the Neo-Carpus in favor of the Paleo-Carpus, with the decay of the biarticular function towards the mono-articular function. Thus, it corresponds too to the re-emergence of an ancestral mechanical structure, already experimented in the Maniraptors Teropods of the Cretaceous (135-65 MAF), whose prehensile carpus possessed a single "crescent bone", homologous to the capitate-hamate, directly articulated to the distal radius.

Iconography of the dysmorphic carpus according to the Regression Principle

To illustrate the Dismorfogenetic Law in the Hand, we will illustrate some congenital and acquired cases:

Firstly, in the Malformations of the Hand, in analogy to those of the Foot, carpal skeletal anomalies of the carpus are easily present due to local arrest of development, that recall the structures of the reptilian carpus (Fig. 22).

Similarly, in carpal evolutionary deformities, like the Madelung and Kienböck's (with a varied genetic penetrance and with a diversified mechanical-environmental component), it is possible to note the regressive function of the Adaptive Carpus (Fig. 23).

Likewise, the establishment of the regressive patomechanics of the Adaptive Carpus is found in the s.c. carpal Involutive Deformities resulting in traumatic distal radius damage or in the SNAC-SLAC-SCAC wrist degenerative process, etc. (Fig. 24).

First, we will focus on the systemic surgical treatment of such regressive carpus.

RESULTS

COXA MANUS SURGERY versus FOOT SYSTEM SURGERY

From the Biarticular Concentric Carpal Mechanics (BCCM) and from the natural para-physiology of the Adaptive Carpus, the Coxa Manus Surgery (CMS) is logically derived, according to the axiom: "*the new post-surgical normality of the carpal injures must aim at the restoration of mechanical functions and obtain the repositioning, also substitutive, of the Carpus Rotation Center (CR)*".

Namely, in the specific carpal damage, first of all it is necessary to evaluate the possibility of *restitutio ad integrum*. If this is feasible, then to reposition the CR it may be sufficient osteosynthesis and/or repairs of possible ligament injuries (e.g., in a fracture and/or scaphoid pseudoarthrosis, or in an S-L dissociation, etc.). Viceversa, when anatomical reintegration is not possible, we proceed with solutions that use the mechanical potential of the parts that are still intact and/or that optimize the natural adaptation process (Grippi, 2002a, b, 2003, 2006, 2008a, b).

The Grail of Wrist Surgery

In particular, with this methodology the importance of surgical recovery of the radiocarpal joint, and/or of the damaged carpal bones is reduced; these, at most, can be sacrificed.

To compensate, a valid option is to simplify the function of the carpal mass, concentrating all the movement on the head of the capitate or, if too damaged, on a substituted cephalo-capitate prosthesis.

This last concept represents the "Grail" of Wrist Surgery: with a fundamental methodological principle, that the empiricism of traditional surgery had already unknowingly applied in the Proximal Carpectomy, with excellent results. However, the BCCM allowed to understand that this bone resection corresponds to a simple meniscectomy, and that after this operation the axis of the hand and that of the radio-carpal joint continue to converge on the capitates head, where, on the radio, reconstitute a new CR (Grippi, 2013) (Fig. 25).

The main surgical procedures

In any case, in order to reset the CR in any hypothetical carpal damage, the CMS considers four main surgical procedures, of which the first two to be implemented in case of integrity of the head of the capitate (GRIPPI, 2002).

Respectively:

1) the *Center-carpic Resection (CR)*: corresponding to the Proximal Carpectomy, in which the capitate is made to articulate directly on the lunar dimple of the distal radius, which must be intact. The intervention, indicated in the irreparable damage of the carpal condyle (and preferably in the adult and/or elderly with little work commitment), is useful in case of stiffness because it shortens the carpus up to 2-3 cm, recovering space to movement.

2) *Coxa Manus Reconstruction (CMR)*: consists of radio-carpal arthrodesis with resection of the distal scaphoid: radio-lunate-(hemi)scaphoid arthrodesis. The intervention - indicated in the recovery of the flexion-extension and/or ulno-radial deviation, mainly in the young and/or adult (albeit in working activity) - models a neo-Cotile Manus that accepts the head of the capitate with the CR definitively stabilized, and which transforms the CMR into the unique articulation of the carpus. In this way, any residual movement in the damaged radio-carpic articulation is eliminated; and viceversa, the one of the uninjured mid-carpal joint is amplified; thus optimizing the natural adaptation process from bi-articular to uni-articular mechanics. A technical variant of CMR is used in Kienböck's disease at stage III-IV where the collapsed lunate can not be used to reconstitute the Cotile Manus. In this case, the intervention is however carried out by means of the osteotomic translation of the radius lunar facet, close to the capitate.

However, both CR and CMR are contraindicated if the carpal injury includes damage to the capitate' head. In this case, in order to overcome the obstacle, a cephalic-capitate prosthesis can be positioned in the corresponding twin procedures. Respectively:

3) *The Substitutive Center-carpic Resection (SCR)* consisting of an CR plus the cephalic-capitate prosthesis.

4) *The Substitutive Coxa Manus Reconstruction (SCMR)* consisting of a CMR plus the cephalic-capitate prosthesis. In the case of limited damage to the capitates head consistent, instead, only in the prosthetics (Fig. 26).

Clinical use of the CMS and our case studies

Using the basic operations of the CMS (in parti-

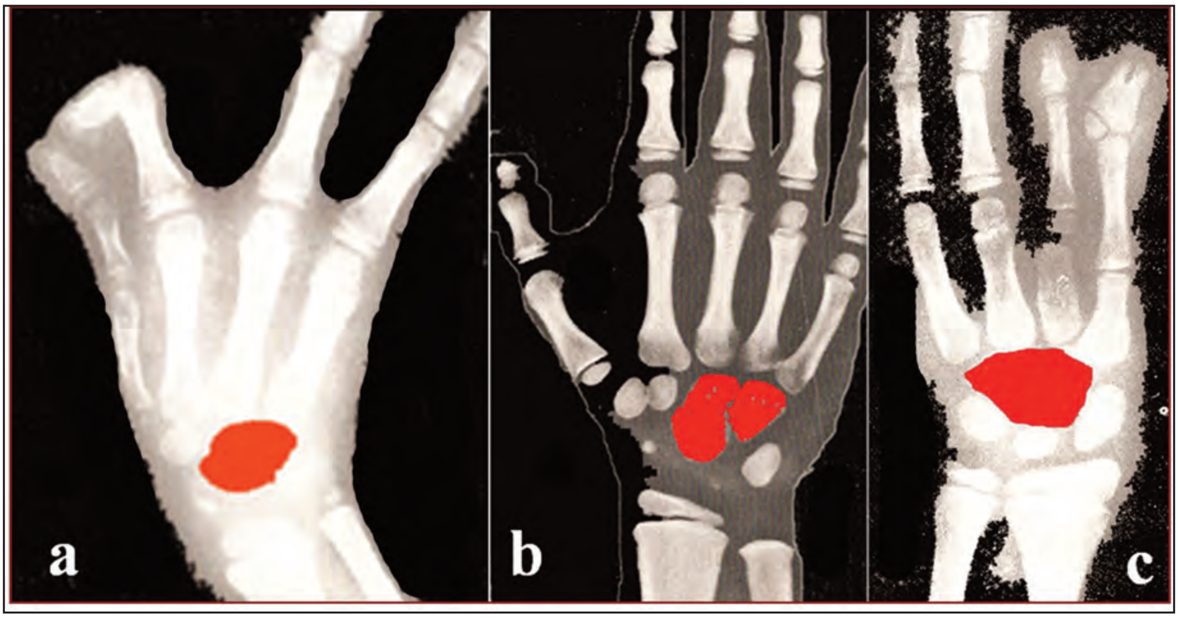

Figure 22. Exemplification of the Dismorfogenetic Law in Malformations of the Hand from local arrest of the development for genetic diseases: a) - Oligosyndactyly in a 6-year-old girl; b) - Picnodistosis in a 7-year-old girl; c) - Complex malformation in a child of 10 years. In all these cases, the Paleocarpus (capitate and hamate) is melted and more ossified (mature) than the Neocarpus, to recall the carpal reptilian configuration.

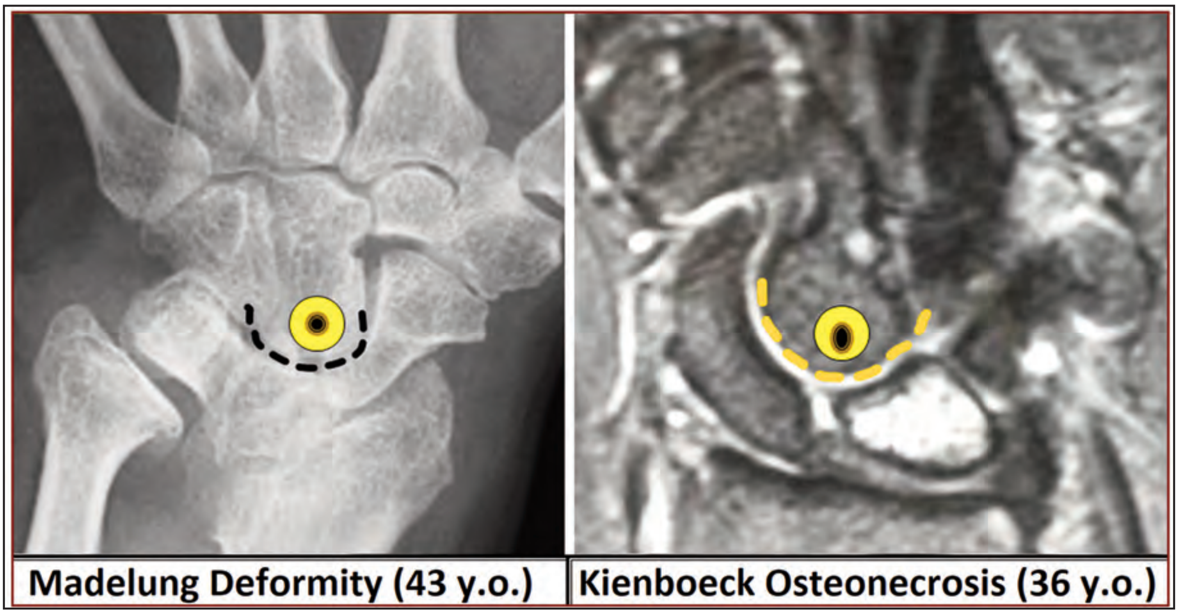

Figure 23. Exemplification of the Dismorfogenetic Law in certain Evolutionary Deformities of the Hand such as Madelung and Kienböck's, from variable pathogenic genetic-environmental mix, in which it is possible to highlight the loss of the biarticular mechanical structure towards the regressed uniarticular structure, focused on the Coxa Manus (so-called Adaptive Carpus).

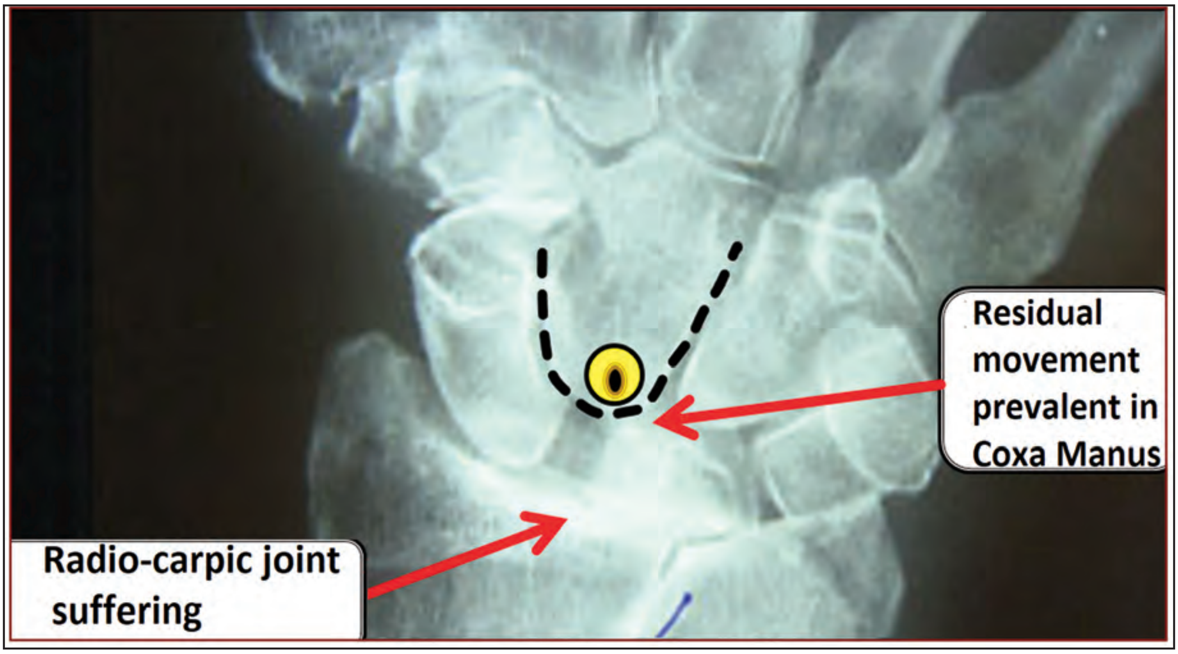

Figure 24. Exemplification of the Dismorphic-Genetic Law in certain Involutive Deformities of the Hand like the SNAC - SLAC - SCAC pulse, consequence to traumatic and/or degenerative input, in which it is possible to highlight the loss of the biarticular mechanical structure towards the regressed uniarticular structure, focused on the Coxa Manus (so-called Adaptive Carpus).

cular, the Coxa Manus Reconstruction) it is possible to treat wrists with extreme damage. This recovery is obtained with minimal anatomical subversion and with the guarantee, in the eventuality of a hypothetical failure, to easily fall back on more definitive but destructive interventions, such as pan-arthrodesis or total prosthesis.

This latter aspect places them as strategically alternative and of first choice, with the futher advantage of "polyvalence". In fact - excluding the wrist with active inflammation (rheumatoid, infectious, etc.) and/or with poor bone (severe osteoporosis, neoplasia, etc.) - they are used in many carpal disorders, including: the SLAC (Scapho-Lunate-Advanced-Collapse) and SNAC (Scaphoid-Non-union-Advanced Collapse) the arthritic and/or SCAC (Scaphoid Chondrocalcinosis Advanced Collapse) wrist, the outcomes of the distal radius fractures malunion and/or evolving arthritis, the failures of surgical treatment of scaphoid pseudoarthrosis and secondary injury to unsuccessful treatment of the traumatized wrist, the Madelung, the collapsed Kienböck's, the isolated injures of the capitate head, etc.

Specifically, as mentioned above, the indication is conditioned by the integrity of the capitate head and/or the relative degree of rigidity. Namely, with the intact capital proceeds with the CR if the articulation is reduced more than 50%; with the CMR if the articulation is reduced by less than 50%. Viceversa, in the cephalic damage of capitate we recommend the prosthesis in the corresponding interventions: the SCR if the articularity is reduced more than 50%; the SCMR if the articulation is reduced less than 50%.

Our case studies and technical details of the CMS are reported in the published works, and to these we refer (Grippi, 2002a, b, 2003, 2006, 2008a, b, 2013a, b, 2015; Grippi & Pompilio, 2002).

For the purpose of exemplification, however, we will expose some cases to various pathologies, which have been successfully treated and resolved.

Iconography CMS

Case 1: Madelung disease (pre-operative) (Fig. 27). Postoperative monitoring 14 months after the Coxa Manus Reconstruction + Sauvè Kapandj operation, with valid recovery (Fig. 28).

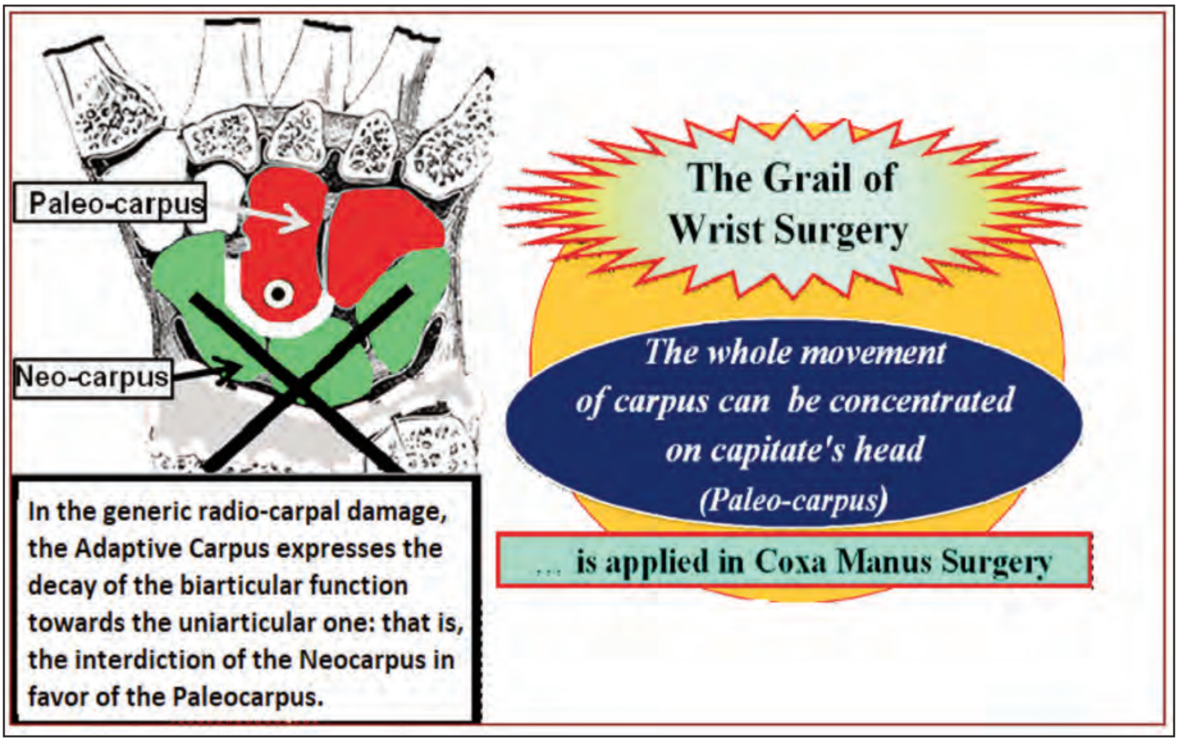

Figure 25. The Grail of the Wrist Surgery resizes the importance of the recovery of the radio-carpal joint and/or of the damaged first carpal row; because, at the limit, both can be sacrificed.

Case 2: Kienböck's disease (pre-operative at IV stage) (fsee Fig. 29). Postoperative monitoring at a distance from the Coxa Manus Reconstruction, with valid recovery (Fig. 30).

Case 3: case of unrecoverable pseudoarthrosis of the scaphoid post-synthesis of trans-schapho-perilunar fracture-dislocation of the carpus (Fig. 31); valid recovery was obtained with the Coxa Manus Reconstruction (Fig. 32).

Case 4: this case shows a severe stiffness and dorsal sub-luxation of the right wrist after a poorly established fracture (Fig. 33); valid recovery was obtained with the Coxa Manus Reconstruction (Fig. 34).

Case 5: SLAC-SCAC wrist case with carpal collapse and cephalic suffering of the capitate (Fig. 35); valid recovery was obtained with the Substitutive Center-carpic Resection using HGP prosthesis of capitate (Fig. 36).

Case 6: SCAC wrist case collapsed with cephalic necrosis of capitate (Fig. 37); valid recovery was obtained at a distance of 2 years from the Substitutive Center-carpic Resection with a mini-total implant of HGP prosthesis (Fig. 38).

THE FOOT SYSTEM SURGERY

The systemic behavior enunciated by the Dysmorfogenetic Law in the foot provides the Clinic with a general explanatory paradigm of the dysmorphic event and a real predictive reference in the prognostic evaluation, useful for the prevention and prophylaxis of the damage “in itinere” and fundamental for the design and surgical indication .

In this sense, regardless of the amount of regression present in a given dysmorphia of the Foot and in relative independence from its etiology, the best possible treatment must propose in any case the optimization of the phylogenetic profile, (obviously, based on the dysmorphic type, the suprasegmental inferences, the age, etc.) with interventions suitable for the recovery of the best morphological configuration still possible, in opposition to the Regression Principle.

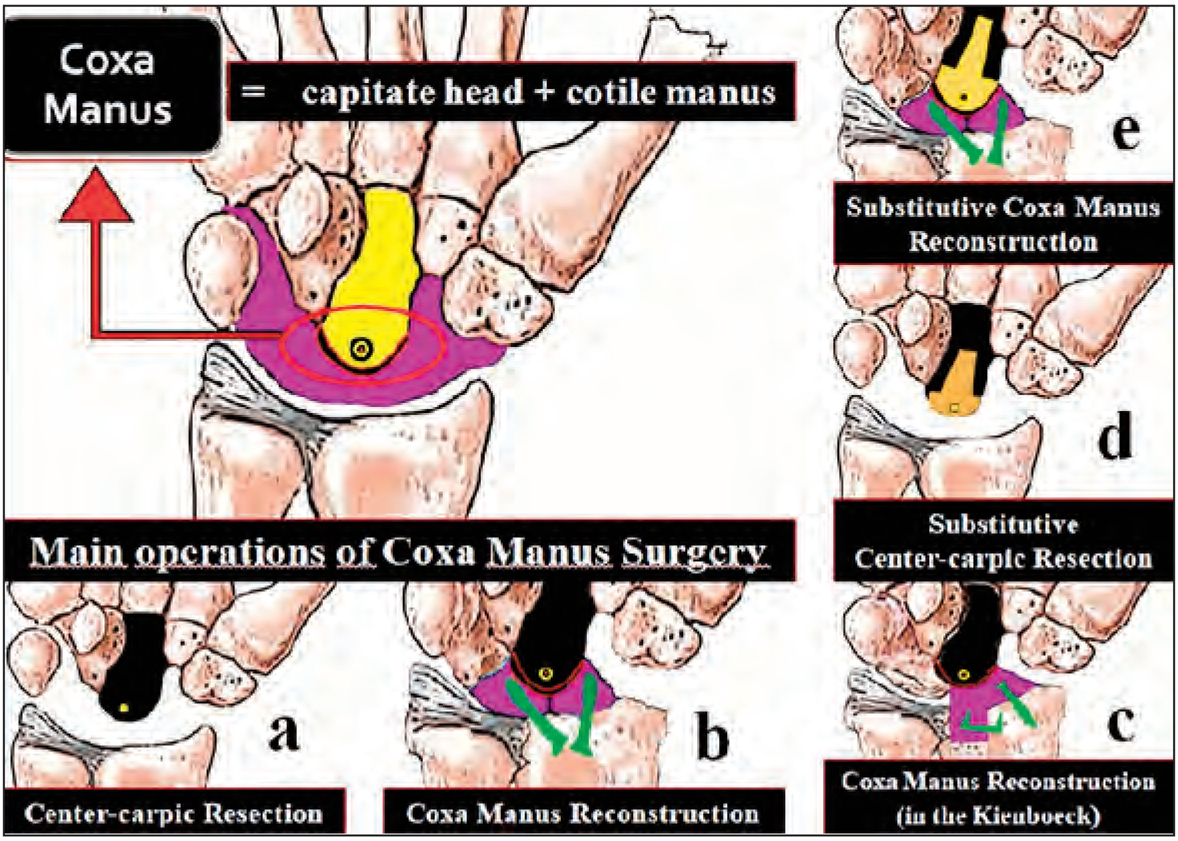

Figure 26. Coxa Manus surgical procedures (see text).

Moreover, in order to improve the surgical compliance and to favor the optimal recovery of the cerebral movement patterns, it is advisable, where possible, the simultaneous treatment of all the deformities.

Another usefulness comes from considering that, unlike the hand - which privileges the movement to stability - the systemic role of the foot demands the opposite. This - in surgical practice - recommends the relative minor use of soft tissue interventions, as the correction obtained at the bone level is certainly more effective and lasting in terms of stability. In particular, in correcting a given deformity and in the absence of clear local references, the best procedure is to sculpt the bone architecture in the direction of normal anatomy and / or model the healthy, contralateral foot.

A final consideration regards the surgical implications deriving from the fact that in the evolution of the primates the development of the heel had (also) the significance of providing the ankle of a structure capable of absorbing the energy of a possible fall from the trees, to protect the astragalus.

This explains the chances of recovery of calcaneal sub-thalamic fractures even in cases of malconsolidation of the sub-Astragalic Articulation (AS); even in surgically treated cases in which the joint tends, however, to develop ankylosis. In fact, in the treatment the best outcomes achieve the correct positional reduction of the calcaneus (that is, not in talo or varus/valgus or in conflict with the fibula, etc), rather than the reconstruction of the articular surface.

Actually, the post-traumatic ankylosis of AS involves acceptable functional damage because, however, it corresponds to a regression that recalls the molten tarsus (os astragalus-calcaneus) of the Syntarsus of the Jurassic reptiles (203 - 135 MAF), with a mechanical structure that in phylogenesis lasted millions of years. For this reason, the arthrodesis of SA - considered a "wild" procedure, empirically used in multiple pathologies of the backfoot - is one of the best performing interventions (Fig. 39).

However, if we want in this study to limit the discussion to the systemic treatment of the most frequent Foot Dysmorphisms, we will consider those with a higher incidence and a common outpatient response.

To summarize:

1) The Hallux Valgus and/or its evolution in Triangular Forefoot, which evokes the enlargement of the metatarsal fan of proto-mammals reptiles (Sinapsidi) with also the "opposite" attitude of the first ray, similar to of the arboreal primate (65 MAF).

2) The Flat Foot, which recalls, in the backfoot, the plantigradia of amniotic reptiles (Terapsids, 370 MAF) with incomplete subtalar migration of the calcaneus with also the "opposed" structure of the first ray, similar to the arboreal primate (65 MAF).

In detail, in the light of our experience, these are the main indications and procedures for:

Phylogenetic optimization of the main Dysmorphisms of the Foot: clinical use and our case studies

- In the Forefoot: in the classic Hallux Valgus (HV), we need to evaluate the natural tendency towards progression towards the Triangular Forefoot (TF) (Fig. 40). With reference to the clinical typology and specificity of the patient, the fundamental surgical target counteracts and/or correct the enlargement of the metatarsal fan, in any case acting surgically with a perspective view of the patient's remote future. In this sense, effective interventions are:

1) the Z-Elongation of the Achilles tendon, which dampens the static equinus-pronation and therefore the deforming load of the forefoot. The intervention can be indicated in the young girl's cavus-valgus foot, with symptomatic incipient AV.

2) the corrective osteotomy closing the metatarsal fan with restoration of the correct arch and metatarsal-digital relations. This intervention can be indicated in the simple AV - limited to the exeresis of exostosis and osteotomy of the first metatarsal neck (Fig. 41) - but it can also extend to the V and/or II-III-IV metatarsal - in the various degrees of deformity of a Triangular Forefoot - and, also, complete with the re-alignment of the fingers, when sub-dislocated or in griffes (Fig. 42).

- In the Back-Foot: in the Calcaneus-Valgus of the Flat Foot Evolutionary and/or generic Structured Plantarism - always, with reference to the clinical typology and specificity of the patient - the fundamental surgical objective is to contrast and/or correct the incomplete subtalar migration of the heel. In this sense, effective interventions are:

1) Z-shaped Elongation of Achilles tendon (with external disconnection) reduces the valgus component of the calcaneus in the juvenile evolutionary Flat-Foot. On the contrary, in structured Plantar Flatness, it serves to solve the irreducible shortness' tendon.

2) The plastic retention intervention of Cotile Pedis (according to Pisani), indicated in the evolutionary Flat Foot with accessory scaphoid, serves to strengthen the teno-capsulo-ligamentous support of Coxa Pedis, with relative elevation of the plantar arch.

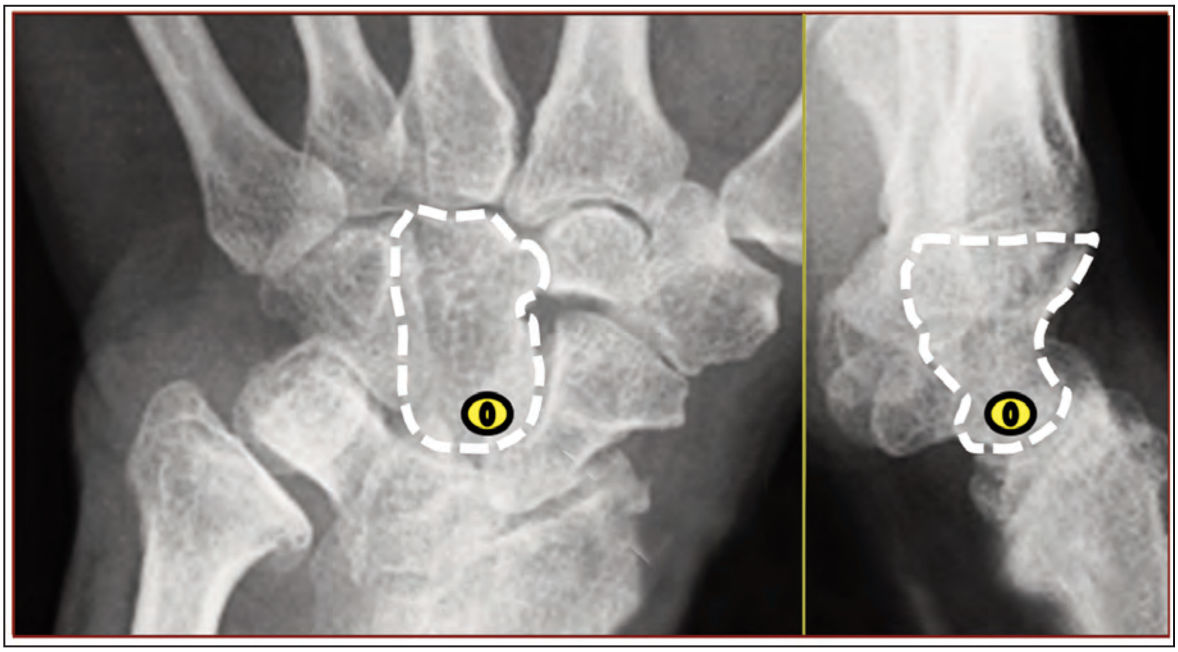

Figure 27. Case 1, preoperative. Symptomatic Madelung in 40-year-old woman: the radio-carpal suffering evolves with conflict, instability of the distal radio-ulnar joint, limitation of the prone-supination and with the movement that spontaneously tends to concentrate in the Coxa Manus, at the center of the carpus (so-called Adaptive Carpus).

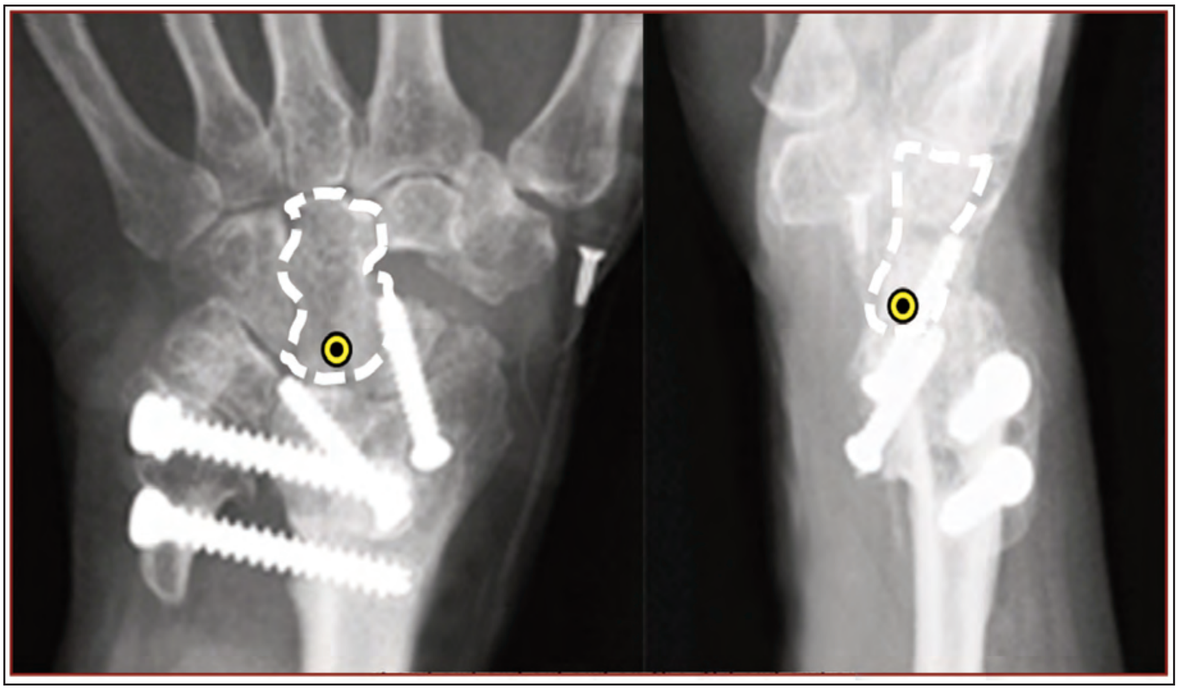

Figure 28. Case 1, postoperative: the Coxa Manus Reconstruction was performed to eliminate the radio-carpal joint and to amplify the movement in the center of the carpus. Sauvé-Kapandji arthrodesis was performed to eliminate the instability of the distal radio-ulnar joint and fully recover prone-supination (4-year control, with good result).

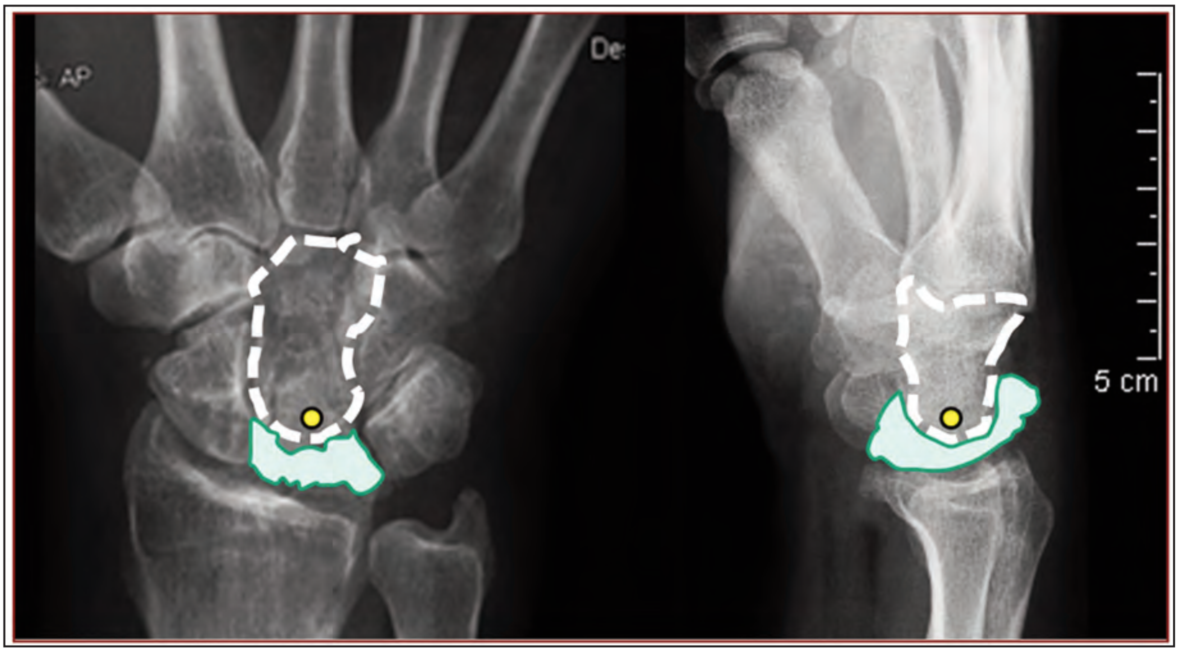

Figure 29. Case 2, preoperative. Adaptive Carpus in 40-year-old male from carpal collapse in Kienböck's IV stage: due to the instability of Kienbock's disease and scapholunate advanced collapse, the wrist is in mechanical block.

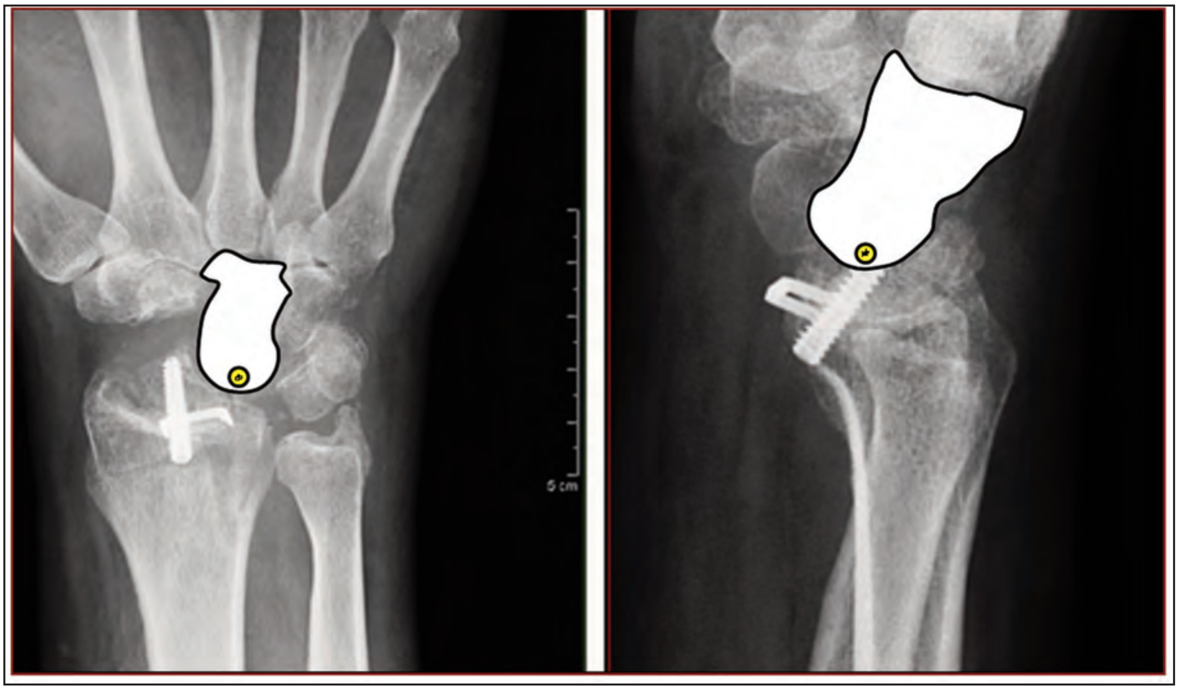

Figure 30. Case 2, postoperative. Coxa Manus Reconstruction surgery (Kienböck's variant) was performed to eliminate the residual painful radio-carpal movement, carpal instability and amplify the movement in the middle of the carpus (6 years control, with good result).

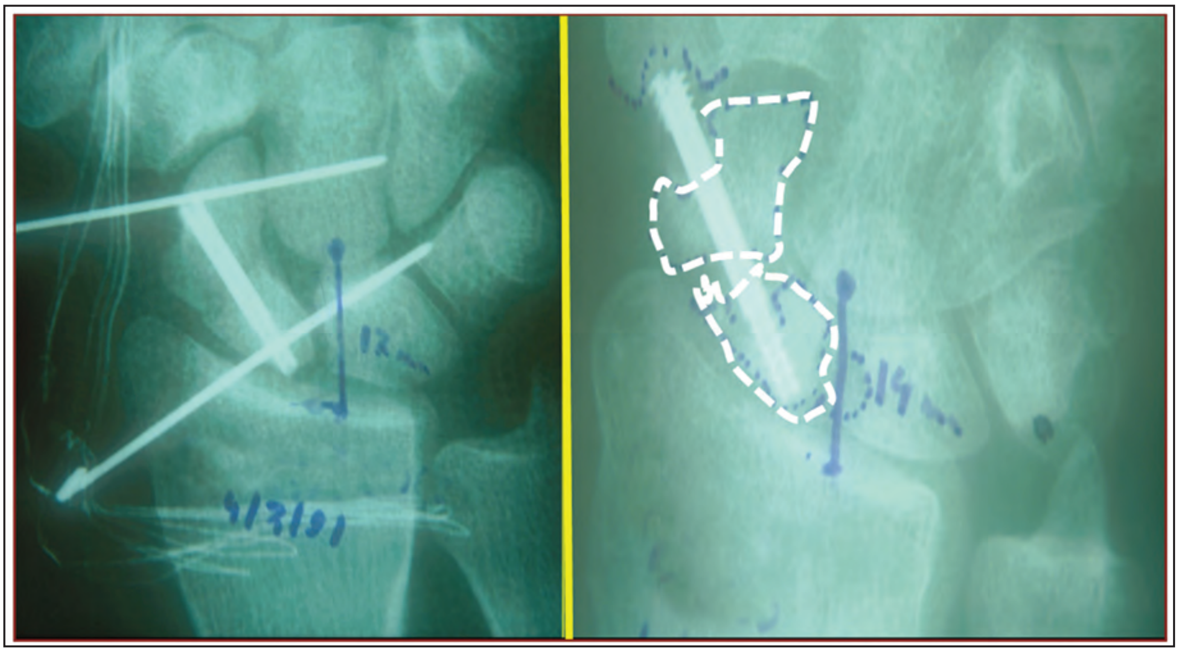

Figure 31. Case 3, pre-operative: 30-year-old male with unrecoverable pseudarthrosis of scaphoid after osteo-synthesis of peri-lunate fracture-dislocation of the carpus.

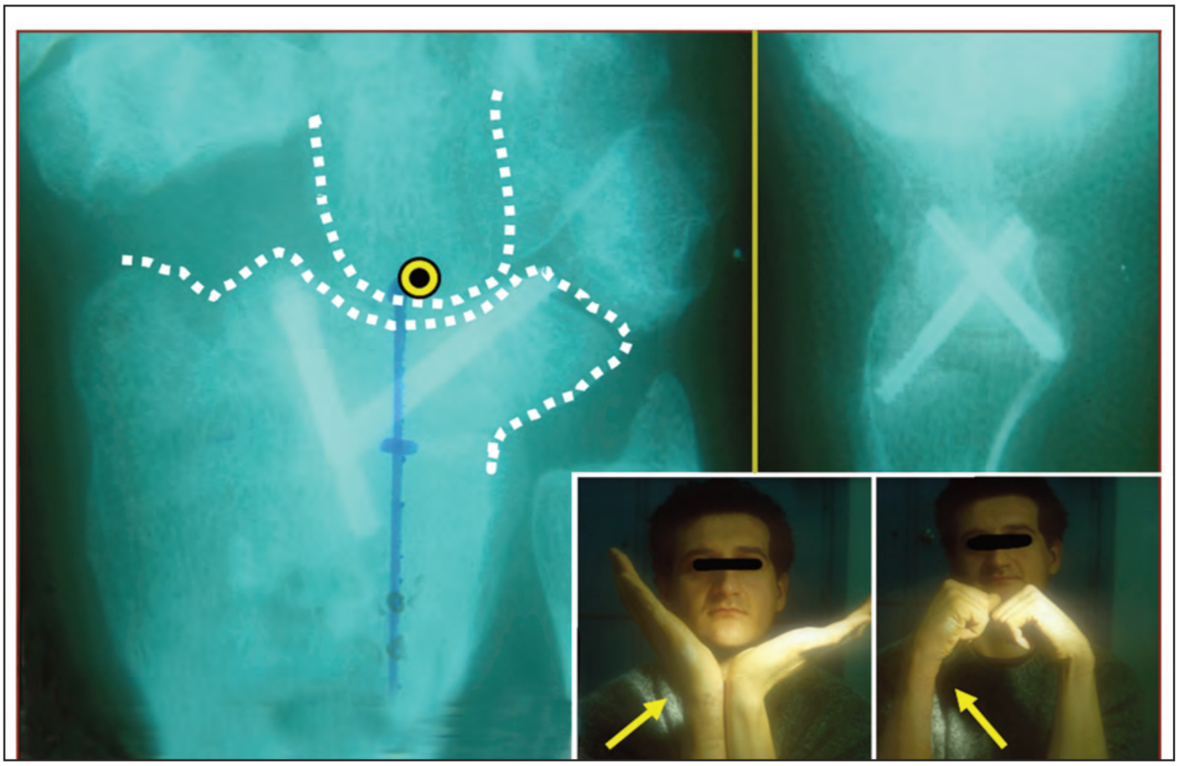

Figure 32. Case 3, post-operative: Coxa Manus Reconstruction was performed (5-year control, good result).

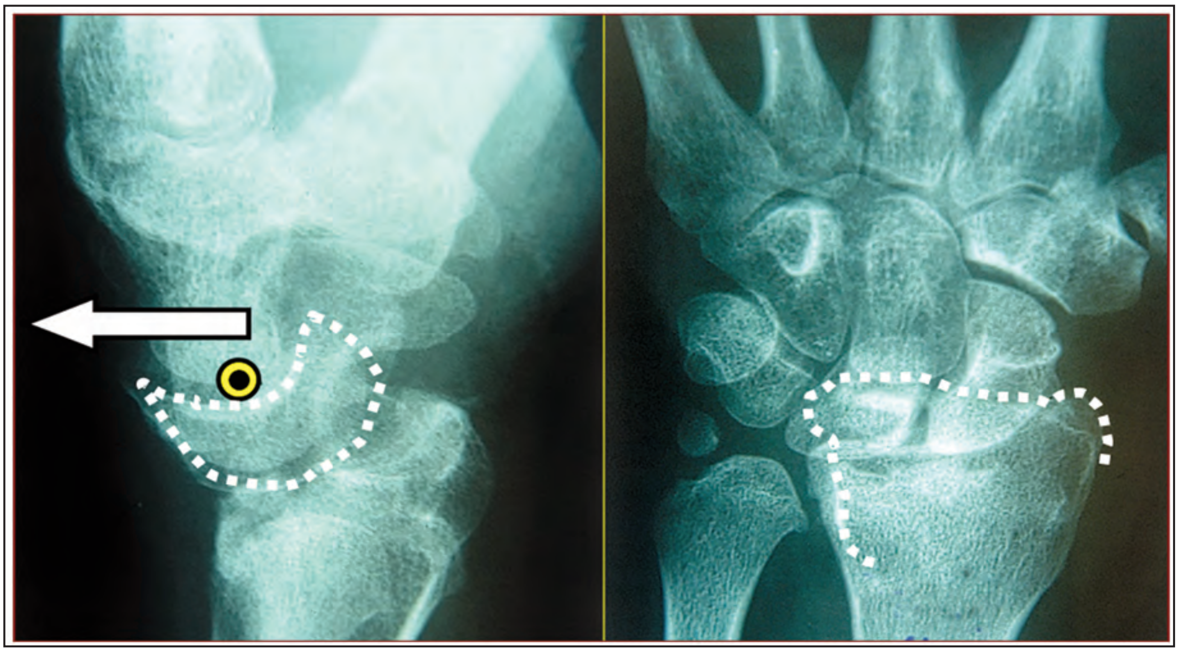

Figure 33. Coxa Manus Surgery Iconography (case 4, pre-operative): Young 30-year-old male with severe stiffness and dorsal sub-luxation of the right wrist, post badly-established fracture of the distal radius.

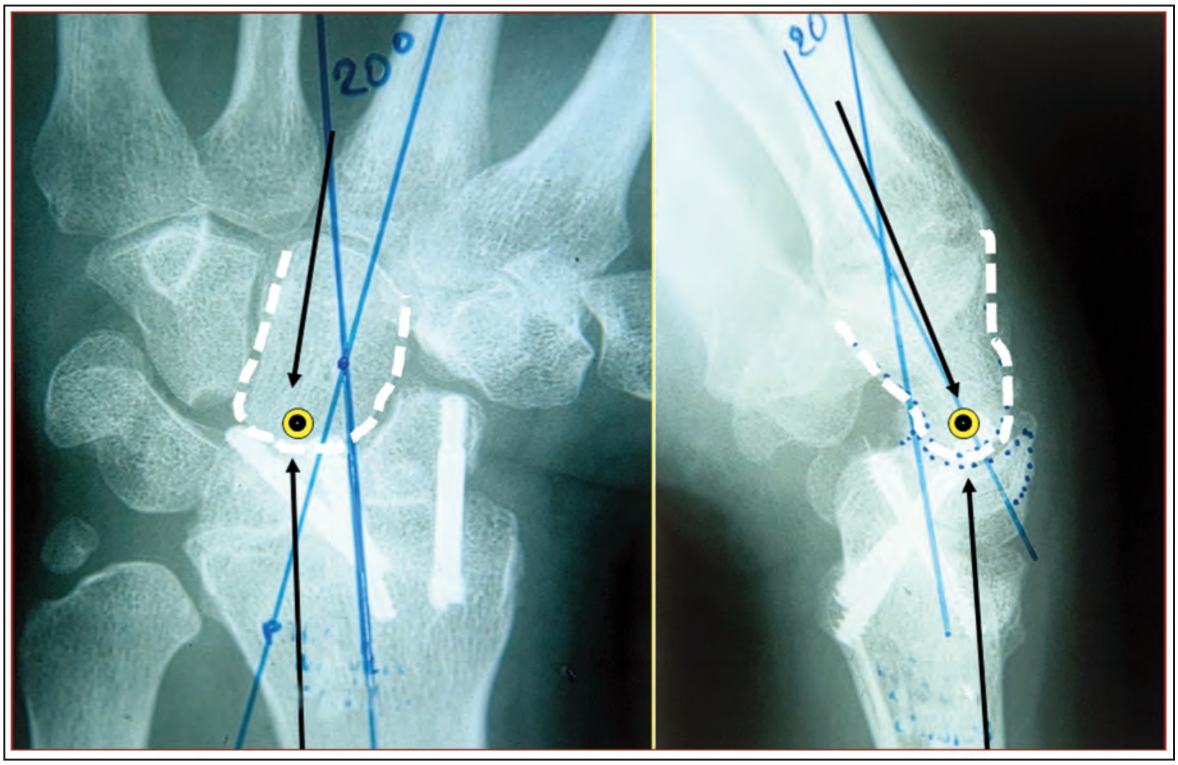

Figure 34. Case 4, post-operative: Coxa Manus Reconstruction was performed, 6-year control, good result.

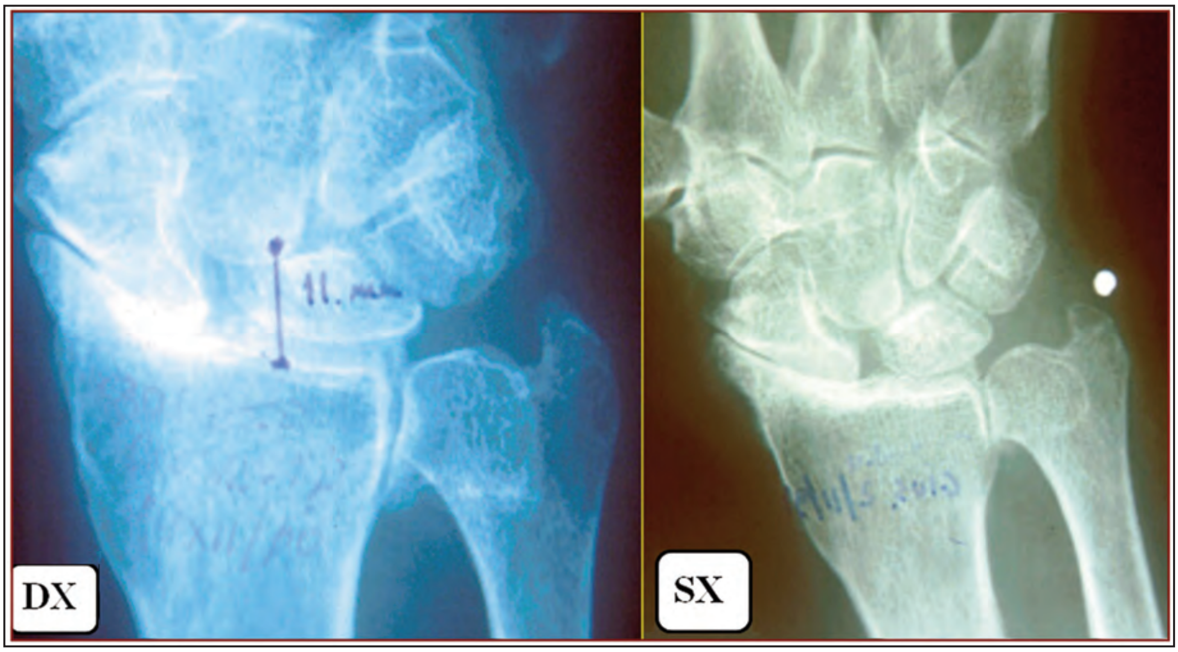

Figure 35. Case 5, pre-operative: 60-year-old pensioner with SLAC-SCAC wrist and bilateral cephalic suffering of the capitate.

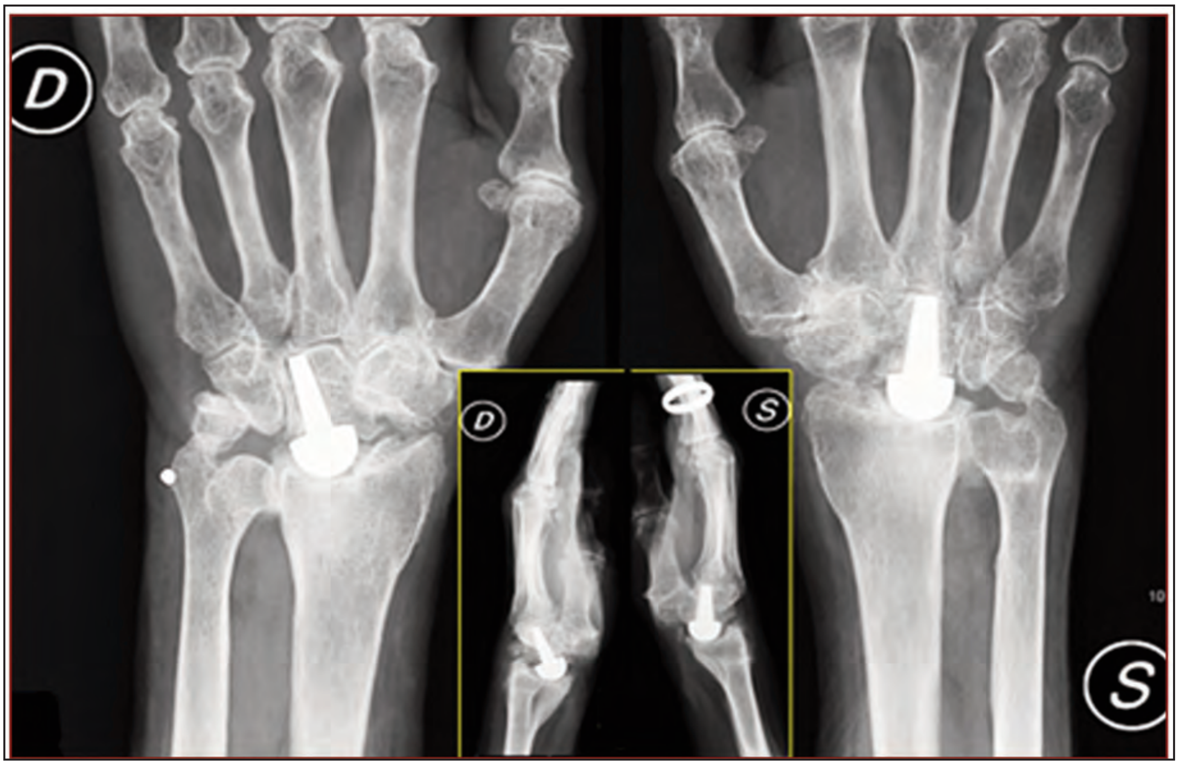

Figure 36. Case 5, post-operative: bilateral SCR with HGP prosthesis of capitate, 7-year control, good result.

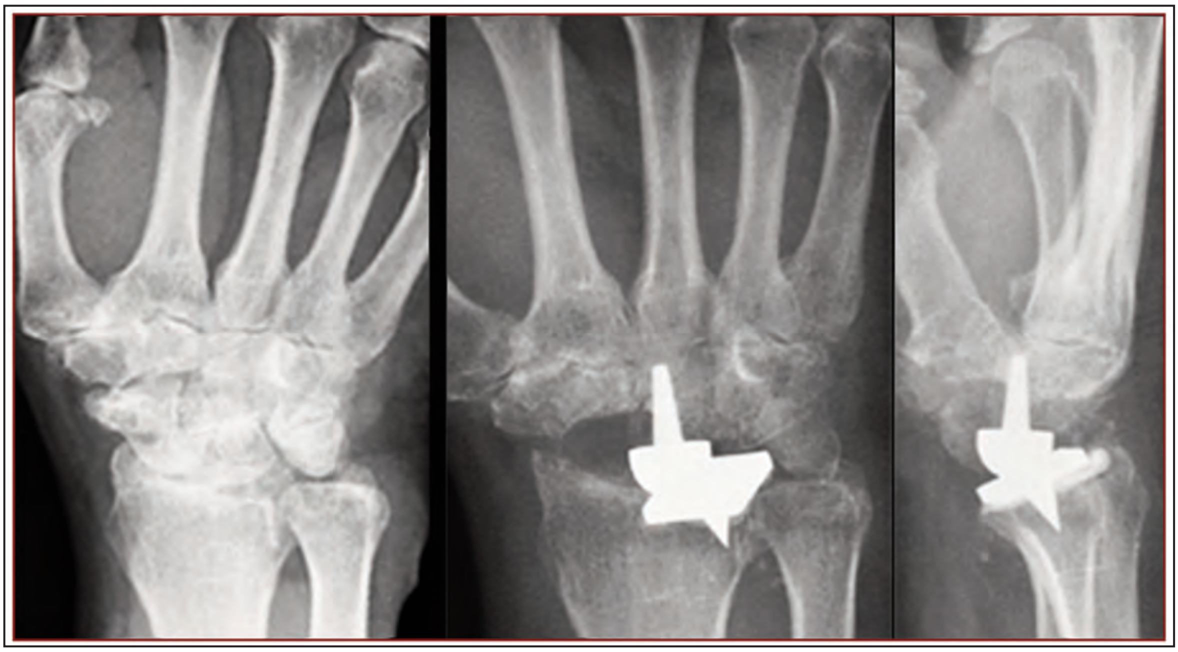

Figure 37. Case 6, pre/post-operative: A) - 70-year-old farmer with severe SCAC left wrist and cephalos-capitate necrosis. B) - the Substitutive Centrocarpical Resection with total HGP prosthesis was performed.

Figure 38. Case 6: 4-year control after surgery, with good results.

3) The diastasis of the astragalus-calcaneal or Sub-astragalic Articulation (SA), the s.c. calcaneo stop, consists in positioning a device (endorhtesis, AO screw, etc.) inside the tarsus able to widen the Sub-Astragal (SA) and force the heel to rotate below the talus (Fig. 43).

This last intervention is particularly indicated in the patient in the developmental age and serves to normalize (immediately) the calcaneal valgus. On the contrary, in the post-operative period, it also modifies (stably) the kinetics of the Load Transmission System (LTS) of the Human body, finally stimulating the Architectural Maintenance and Trophy System to remodulate skeletal growth towards the optimal phylogenetic standard.

In fact, the removal of the device in adulthood allows to verify the maintenance of the correction for the bone restyling in the SA (Fig. 44).

4) Arthrodesis according to Grice or with bone bridge grafting of the SA has the same objective of bringing the heel into correct anatomical position under the talus, but unlike the calcaneus stop, it achieves the astragalus-calcaneal fusion, paradoxically without loss of function (Fig. 45). As already mentioned, this is understandable for the fact that it corresponds to the re-evocation of an “anatomical regress” already present in the Reptiles of the Jurassic and therefore physiologically immanent and still available, in the architecture of the human foot.

Ultimately, this arthrodesis of SA has the main purpose of realizing the optimal verticalization of the meiopragic back-foot: therefore, this intervention is elective in Plantar Flatness in which the genetic component of dysmorphia (especially constitutional laxity) is prevalent. At the same time it is of great utility in the Acquired Flat Foot of the adult, from architectural collapse of the plantar arch to a plastic failure due to overload, by rheumatism, traumatism, etc. In this sense, the intervention must modulate the height and thickness of the bone graft, according to the physiological back-foot axis, estimated on the patient.

Furthermore, it should be added that the clinical variability of such dysmorphic features of the foot is such that the comparison of the aforesaid "regressa" - in simultaneous presence - both in the forefoot and in the backfoot is not infrequent. This association is pre-eminent in subjects, at the extremes of age.

Namely:

1) Young patients with evolving flatness and as-

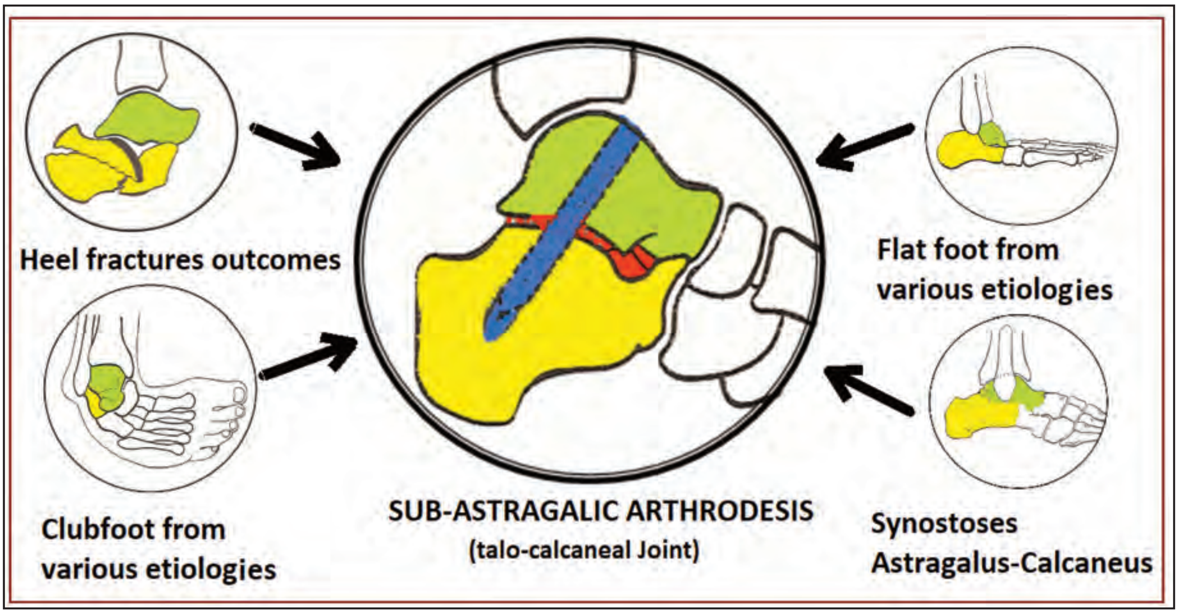

Figure 39. Systemic Foot Surgery: the arthrodesis of the Sub-Astragalic articulation (talo-calcaneal) involves an acceptable functional damage, because it corresponds to a regression that recalls the fused tarsus (os astragalo-calcaneus) of reptiles Syntarsus of the Jurassic (203-135 MAF), with a mechanical set-up that in the phylogenesis lasted millions of years. For this reason, and provided that it obtains the normal verticalization of the back foot, the intervention can be used in many diseases of the back-foot, with excellent results.

sociated incipient hallux valgus. Generally, they are meiopragic subjects for connective laxity (like, Ehlers-Danlos, etc.) in which the relative brevity of the Achilles tendon and connected static pronation is also promoting the enlargement of the metatarsal fan.

2) Patients of the 2nd and 3rd age with a recent catastrophic enlargement of the metatarsal fan (in any presistent modest valgus of the big toe) towards the Triangular forefoot and contemporary painful under-astragalic instability due to architectural collapse of the back-foot. In general, the efficient causes are weight overload, rheumatism or senile degeneration, etc., which have operated on a mildly meiopragic medium.

In both categories, however, it is useful to perform Achilles tendon elongation and the simultaneous treatment of all the deformities and/or bad bone positions (Figs. 46, 47).

CONCLUSIONS

The ideas presented in this study were debated in an ad hoc Seminar, held in Alba in 2009 and represent the fruit of over 35 years of theoretical elaboration and practical application in Hand Surgery and Foot Surgery (Grippi, 2009).

Of course, comparing the two Specialties was an unusual intention, of which there were no precedents, as they are considered (rightly) very different due to the clinical-surgical settings of the disciplines.

However - since the medical-surgical scientific matrix is necessarily identical - it has also been possible to search for the nucleus of knowledge that both have in common - in the very foundations of Orthopedics - and to use a conceptual tool that explains rationally and in the same way the pathophysiology of structural damage in the Hand and in the Foot.

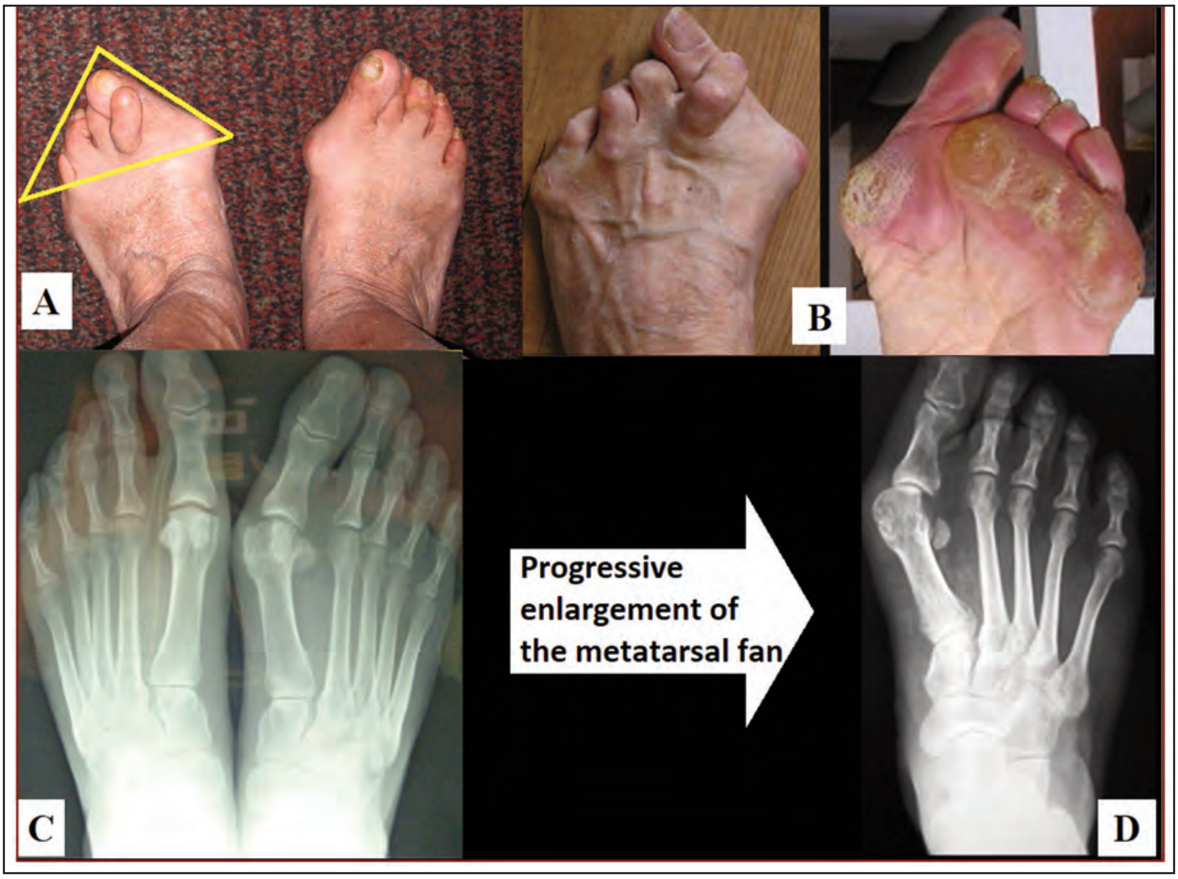

Figure 40. Systemic Foot Surgery: the Triangular Forefoot (A) is the extreme consequence of the progressive spreading of the forefoot (C → D). Sub-luxation and/or "in griffes" of the fingers, metatarsalgia with overload hyperkeratosis, Morton's neuroma, etc. (B), only represent symptomatic epiphenomena - variably expressed and/or overlapping in the various individuals - of the dismorphogenetic process.

It has been possible to derive the methodological suggestions, respectively, of the Surgery of the Coxa Manus and Systemic of the Foot.

The tool in question was the Principle of Regression, pertaining to the cybernetics of Systems Theory, according to which "*in biological structures, the anatomical insult tends to be configured as a re-evocation of the Phylo-onto-morphogenesis, in an adaptive sense*".

The study - in taking a cue from Goethe's morphogenetics - has thus traced the comparative Filo-Onto-Morphogenesis of the Limbs, reinterpreting everything in a modern Holistic-Cybernetic vision, in line with the current orientations of Science. With such premises and exemplifying with facts and concrete clinical cases, what was done in the operating room was the best choice. In particular, specifically in the Wrist Surgery the application of the aforementioned principle has produced effective new rescue interventions that can be used in cases of extreme damage. While in Foot Surgery, it has provided the clinic with a formidable tool for the etiopathogenesis of dysmorphic damage, also suggestive of corrective surgical indication.

Of course, these are tough arguments to stomach for practical doctors who are (considered) orthopedic. In fact, in the doctrine that inspires them, a subtle and articulated theoretical availability is implicit, since to no other physician the relationships between the development of the organic parts, the onset and the changes of the bodily forms namely malformations and deformities acquired) appear so clearly for traumas or diseases among the most varied and the problems related to them. In Orthopedic Science, in fact, development, growth, maturation of the organs of movement are indistinctly considered as one with the realization of the human "form", in a pragmatic vision that in the Normal Anatomy - to be clearer, the idealized anatomy of the Vitruvian Man of Leonardesque memory - has the objective and unequivocal reference of every therapeutic choice, especially surgical. In this sense, the Orthopedist is a practical morphologist physician, knowingly self-obliged to consider ideas of Natural Morphogenetics, to be transferred in opera (*cum manibus*) in his work of surgical craftsmanship.

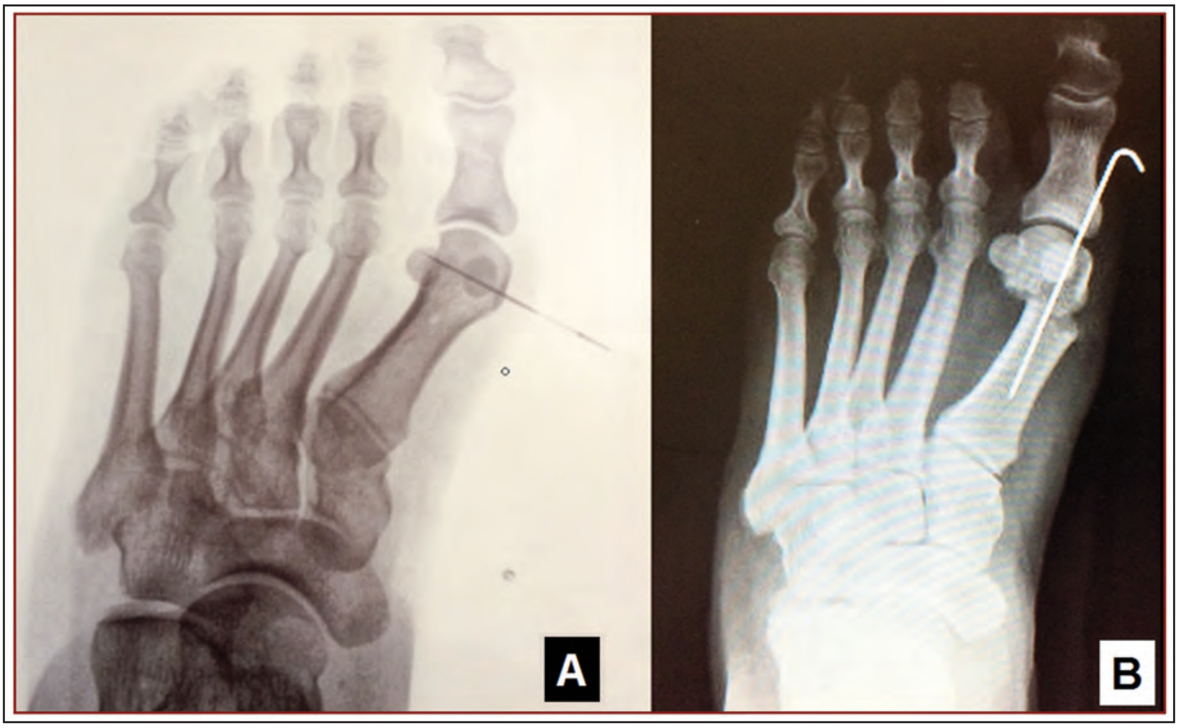

Figure 41. Systemic Foot Surgery with the main Phylogenetic Optimization interventions regarding the Forefoot: A) X-ray of the right foot of a 40 year old worker with Hallux Valgus in painful progression towards the Triangular Forefoot. B) the X-ray control after the minimally invasive percutaneous osteotomy of the I metatarsal neck documents the optimal closure of the metatarsal fan and realignment of the hallux.

Therefore, we believe in this approach of noteworthy contribution to the diagnostic process. In fact, overcoming the current descriptive empiricism of dysmorphic pathology - traditionally considered more or less a static nosological entity - (towards another Systemic-Structuralist vision, vice versa more rigorous and focused on the anatomo-pato-dis-morphic "process", in historical terms) confer temporal perspectival depth to clinical judgment; in the same way that the film tells more than the single frame.

At the same time, another advantage of the systemic approach is therapeutic simplification. In fact, having identified in the "regression" the potential stereotype, with which to interpret dysmorphic damage in relative independence from its etiology, allows us to disregard the traditional nosological categories.

What matters - in a specific case - is the recognition and perspective view of the "process" on that patient. From this to act with the therapeutic act, possibly in a surgical action - that is, with an environmental input designed by the expert mind of the surgeon - to be introduced into the damaged architecture in the direction of the Anatomic Standard - namely, towards the current phylogenetic standard (f.e. correction of plantarism, etc.) or at least capable of realizing some structural simplification - already covered by the Evolution - able to allow the recovery of the function, even at a lower level (f.e. the transformation of the wrist, similar to the carpus of the Dinosaurs, etc) .

This simplification leads almost automatically to the minimal and stereotypical surgical indication. In fact - as it has been shown - it takes only a handful of basic interventions both in Coxa Manus and Systemic Foot Surgery, to deal with most of the more severe structural pathologies of the carpus and / or foot, a common clinical finding.

Finally, in reaffirming our positive experience in this regard, we can not fail to recognize that this intrusion of Cybernetics in Orthopedics is not the promoters at all. Because, simply, we continued the passing the torch started over 40 years ago by the late Prof. Paparella Treccia and that through my Master Prof. Pisani was transmitted to us just 35 years ago, in the Albanian Courses of Foot Surgery of the 80s.

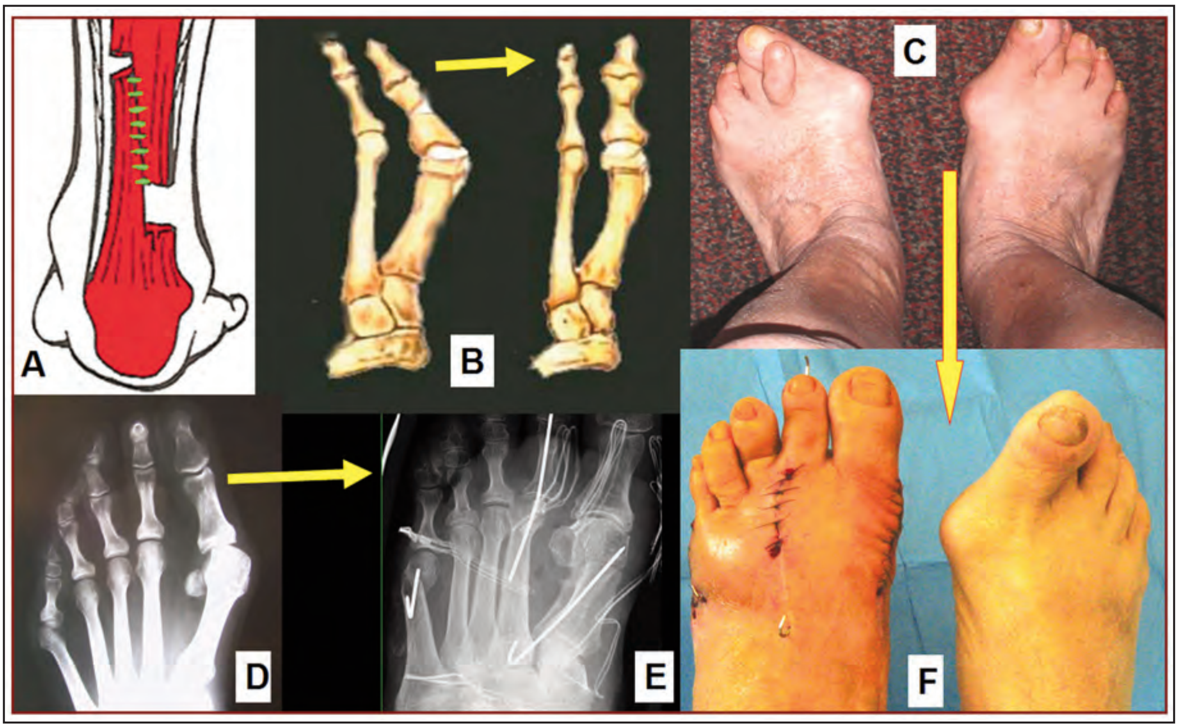

Figure 42. A) Tenotomy of the Achilles tendon with Z-lengthening; B) Corrective osteotomies closing the metatarsal fan; C) Case 2: 60-year-old pensioner with bilateral triangular forefoot; D) X-ray left foot (pre-operative); E) post-operative osteotomy at the neck of I and metacarpal V; F) in the immediate post-operative period the good correction (compared with the counter-lateral foot).

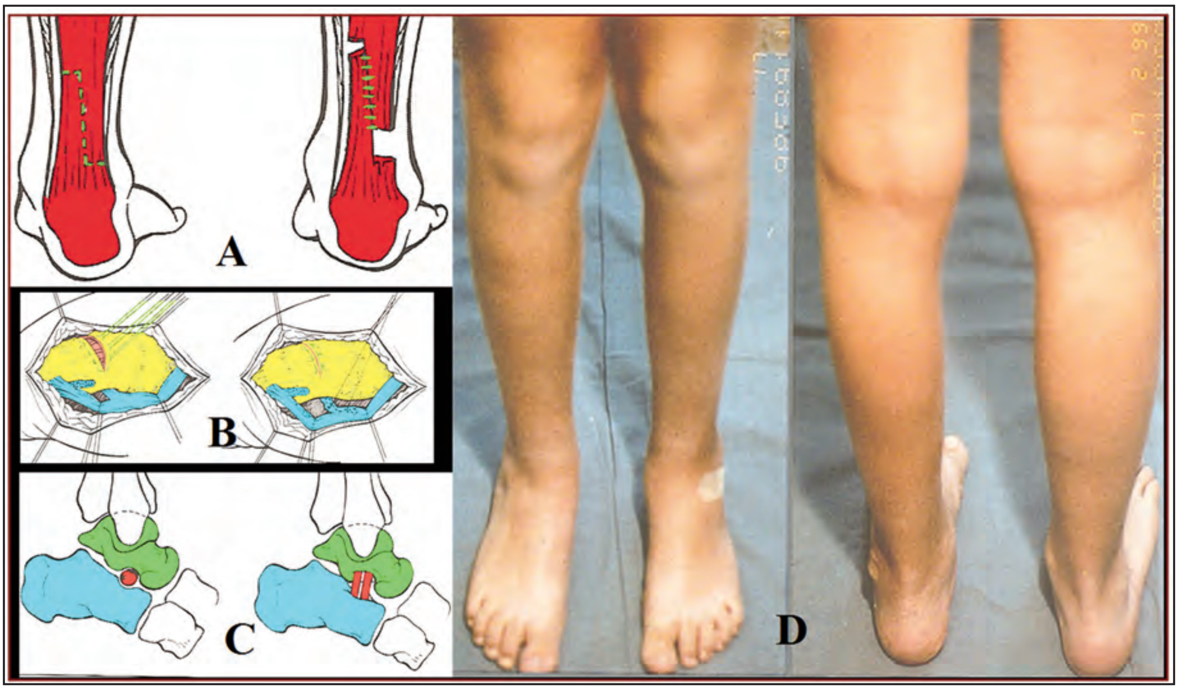

Figure 43. A) Tenotomy with Z-lengthening of the Achilles tendon; B) Plastic ligaments and/or retention of Cotile Pedis (according to Pisani) C) The arthro-dia-stasis of the sub-astragalic joint (c.d. calcaneo stop) or the extratalamic arthrodesis of Grice. D) Case 3: 10-year-old child who has been given the "calcaneo stop" surgery on the left foot, noting the correction of the calcaneal valgus, with respect to the contralateral foot (1 month control).

Figure 44. Case 3: A) - Pre-operative X-ray control: notation of the growth open epiphyses and the fall of the talus with smoothing of the plantar vault B) - control of the result 8 years later (a18 aa): the optimal ascent of the talus is noticeable and the structured resolution of flatness.

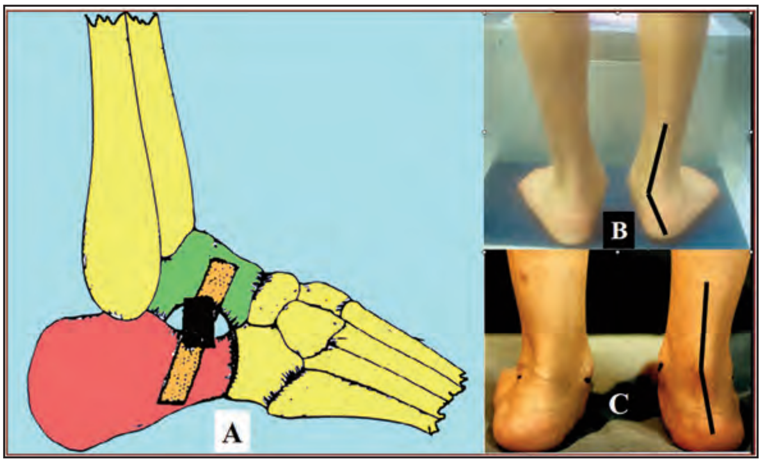

Figure 45. A) The Grice-type arthrodesis. B) Case 4: Bilateral valgus flat foot in adolescent male; C) The clinical control at 1 year from the intervention to the right foot of Grice + tenotomy with Z-lengthening of the Achilles tendon, documents the normalization of the calcaneal valgus with restoration of the plantar vault.

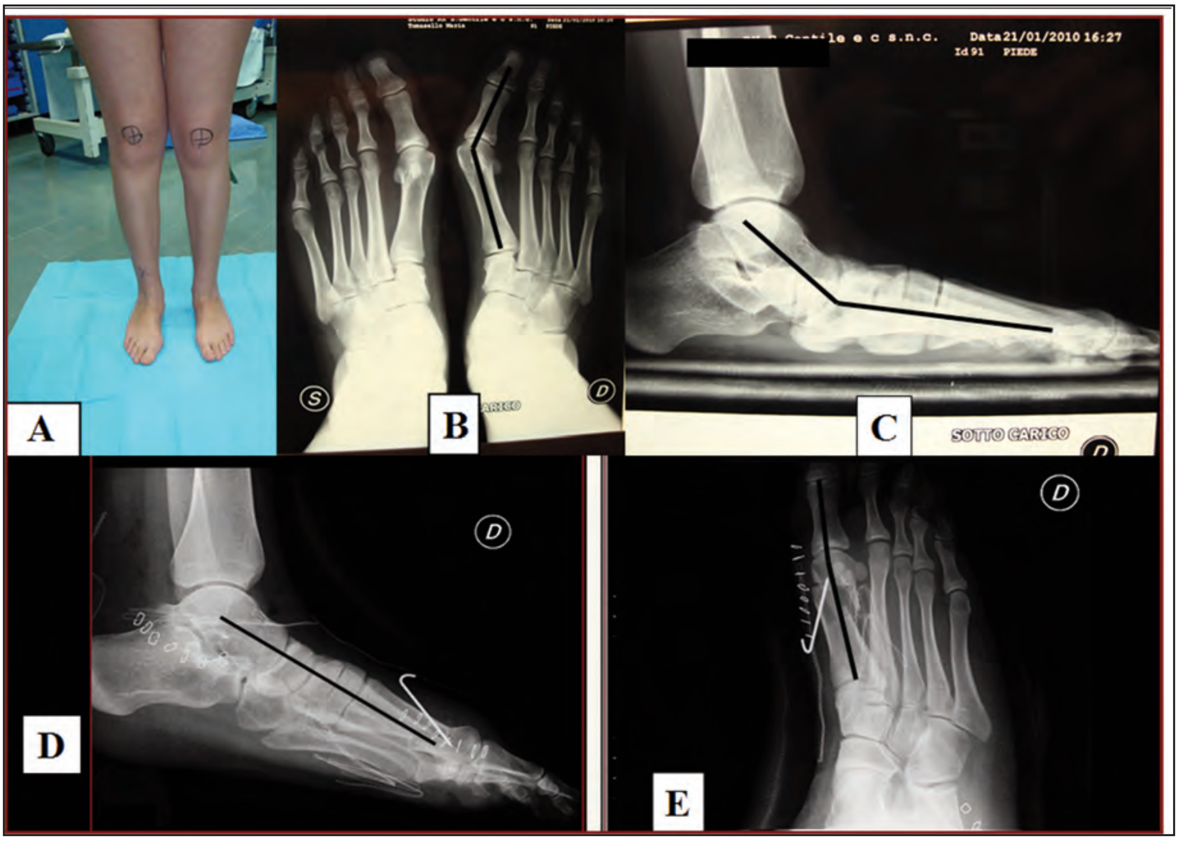

Figure 46. Case 5: 18-year-old female student with Hallux Valgus in bilateral flatness (A-B-C). The X-ray control of the right foot post-intervention "Grice arthrodesis + tenotomy with Z-lengthening of the Achilles tendon + First Metatarsal osteotomy closing the metatarsal fan" documents the reconstitution of the plantar vault and optimal closure of the metatarsal fan (D-E).

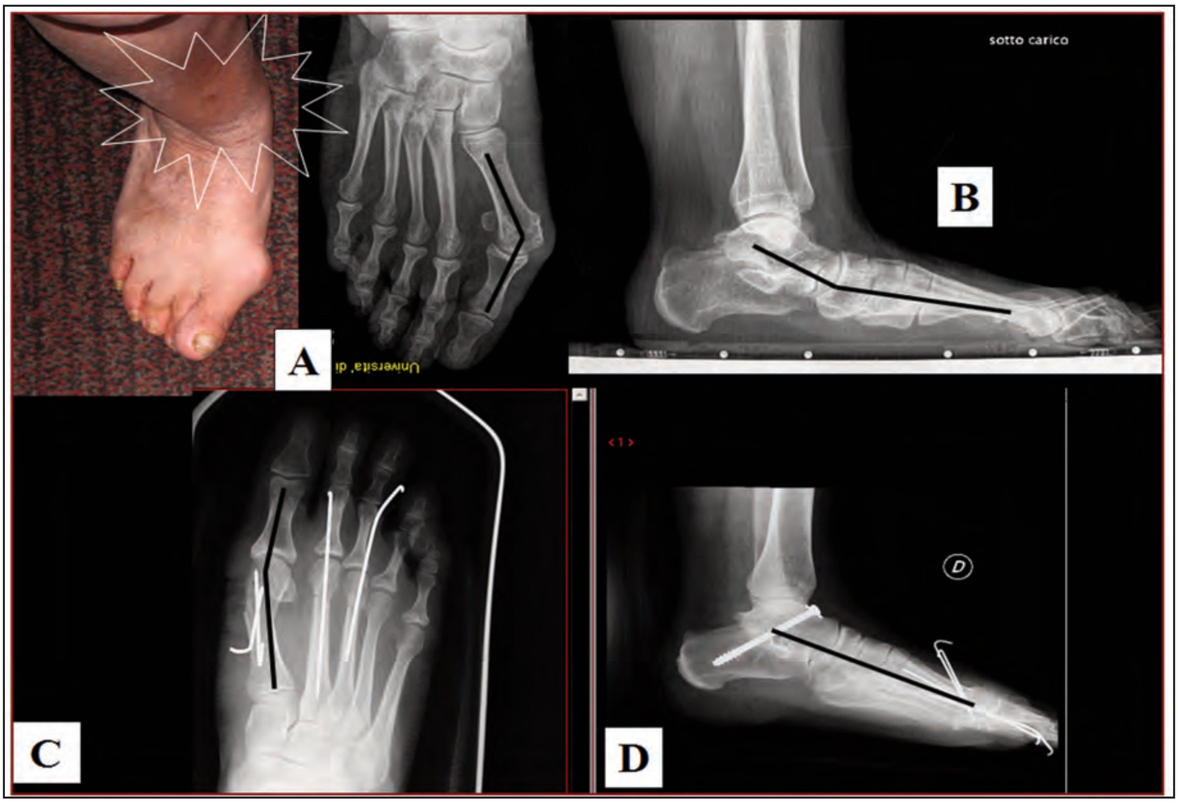

Figure 47. Case 6: 60-year-old female farmer with Triangular Forefoot and painful instability of the Sub-Astragalic articulation by bilateral flatness (with architectural collapse of the back-foot) - (A -B). The X-ray control of the left foot post-intervention of: “reinforced Arthrodesis di Grice + Elongation of the Achilles tendon + osteotomy of the I-II-III Metatarsal in closing and realignment of the metatarsal fan” documents the reconstitution of the vault and standardized closure of the metatarsal fan (C - D).

Last suggestion is to consider this innovation in Hand and Foot Surgery, only local examples. In fact, Systemic isomorphism is applicable in the same way in all the pathological structures and processes of the Organism. And in all likelihood - other surgical opportunities in other anatomic districts are hidden in Phylogeny - yet to be revealed.

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