

## **BIOMECHANICS AND PREVENTION OF INJURIES IN SQUASH**

Biomechanics is the science that allows us to perceive the mechanical movement of the body and the dynamic way in it.

Biomechanics contributes a different way of analysis and understanding of the movements an athlete does, how they use the physical laws, and how they affect positively or not the hit, and above all, this science leads us in search of efficiency and the constant efficiency of movement

It helps us to:

- \* identify what the optimal technique is;
- \* better the diagnosis and corrections of the technique and movements;
- \* understand how power is generated, and control the hits and movements;
- \* increase the knowledge of the features of modern squash;
- \* bring and use what has been analysed from the scientific area to the courts and training, with concrete methodology and didactics where the player can really feel and in a practical way correct and optimize their performance (Tai Chi Squash)

The relationship between the highly competitive sport practice and biomechanics consists of the necessity to improve the sport technique not only through training but also through teaching. A really effective and technical training presupposes that both the sportsperson and their coach know the most efficient movement cycle. It should be taken into account that a sport movement should be studied, not just in a visual way but also in an objective way, considering certain criteria or efficiency factors.

Movement is not a chain of details but a structure that differs in details, it is a full structure. When the rigid parts (the bones), the elastic and the flexible (ligaments, muscles and tendons) vary the grade, the nature of their participation in movements guarantee varied possibilities of movements.

### **BIOMECHANICS- TECHNIQUE- STYLE**

#### **BIOMECHANICS- Laws and principles**

#### **TECHNIQUE- Basic technical concepts/ Complete Swing**

#### **STYLE – Practical application with individual expression**

#### **TECHNIQUE:**

That technique that allows a more efficient combination of power and control both in the technique of knocking and movement, and at the same time reducing to a minimum the risk of injuries.

## **1-Elements of the technique:**

Efficiency- Economy: less energy waste

Efficiency- Result: winning shot

Security- Injury free

## **2-Benefits of the technique:**

Power- Control- Health

## **3-Ball control:**

- Where?
- How?
- Why?
- When?

## **4-B.T.C.: Basic Technical Concepts**

- Body position

- Impact points: height of the ball bounce at the moment of the impact and the relationship of the impact with the fore leg line.

-Balance and equilibrium

- Grip: hand and wrist

## **5-Complete Swing**

**“Movement of the whole body at the time of the hit”**

- Head
- Trunk
- Striking arm, and non striking arm
- Fore leg and back leg

Coaches generally focus their observation only on the arm movement, on what can be seen in the impact, and this represents a limit, since the most important and less visible action is the body production of force and energy, and the way they are transmitted during the impact. This occurs, in general, because of a very limited learning scheme that does not take into account a more integral vision of the movement; i.e. a scheme based on a model that copies the technique of a successful player or the teacher's own gestures. Mechanics knowledge is essential in order to distinguish between what is important or not, what is correct and incorrect, and also to see the distinction between cause and effect.

**“WHEN TRAINING, ANYTHING CAN BE DONE, EXCEPT FROM PAYING THE CONSEQUENCES.”**

## **STYLE:**

It is the personal representation of a technique. It should be allowed as long as it does not produce injuries or a clear efficiency decrease in the play.

## **BIOMECHANIC PRINCIPLES**

They will allow an evaluation of the movement based on physics laws, which are not modifiable, and are absolutely necessary in order to achieve optimization of performance reducing the chances of injuries (invisible technique). This innovative way, with an observation system, divides the hit into observation and work phases (Basic technical concepts; complete swing). There is a system for learning, correcting, and maximising the players' hits, assuming that the racket is a transmission object, the grip is the junction point between the body and the racket, giving orientation with the position of the wrist, the face of the racket, seeking a complete and absolute control of the racket.

It is important to value what happens in the body, from the first activation, followed by preparation, impact and deceleration and production of the hit. The generation of all this force that is transmitted in the impact starts in the ground, from the biggest muscles to the smallest, ending up in the hand, which will transmit the result to the racket and the ball.

**1. BALANCE (equilibration):** when the results of all the forces that perform in the body equal zero. There is balance in repose, in movement and in the air

*Stability:* depends on the surface of the support base, the height of gravity centre, the distance between the gravity centre and the level that has to be exceeded to break stability and weight.

*Balance:* the ability to keep equilibrium either in a static or a dynamic way.

For the player to get out of the static balance, a corporal activation of flexion and pressure is produced against the ground, with a transfer of weight and gravity centre to one of the pillars of the support base. This situation of change is permanent in our sport.

Balance fulfils a key function in the development of hits and mobility, either in the reaction towards the ball or in the retrieval, and it determines the success or loss of a situation.

Three areas play in favour of the player's balance: alignment of the head; inclination of trunk and support platform.

*The gravity centre:* rarely comes from the pelvic cavity: it is the meeting point of the bulk of all the minute particles of the body with a gravity force.

*Weightlessness:* when a person is standing, the gravity force acts on the body (weight) and it is counteracted by a similar force in contrary direction.

“When a person stops having contact with the ground, the situation of pressure that is exerted by the weight against the ground does not exist and that makes the neuromuscular receptors in the feet stop feeling pressure and consequently feedback is removed.

The body, once it does not have reaction with the ground, moves to a state of transitory weightlessness. This state promotes an increase in mobility, but goes against control. This applies not only to jumps but also to the movements of strides or **lunges**. Understanding how gravity and weightlessness act on the human body, will surely help us understand how better controlled are the movements with knee flexion.

*Static balance:* it is to keep balance when the gravity centre is on a support base.

*Dynamic balance:* same as above but when the body is in motion. It is of crucial importance for the performance of hits and later retrieval.

**2- INERTIA:** 1st Newton law: it is the opposition of a body to alter its movement. From Latin: sloth, laziness

**3. LAW OF ACTION AND REACTION:** the generation of strength should be done upwards, from the bigger muscles to the smaller ones, in a synchronized way through the kinetic chain. In squash this is a double work since it is necessary to strike and uphold downwards at the same time after breaking inertia and the starting force.

“Each action is responded by a similar opposite reaction.”

For what mechanical reason do ground shoes have to have a relatively hard sole in their front?

The power that boosts the runner is the one that exerts the ground against them (reaction). To make the race efficient, that power has to be the same as the one exerted by the runner against the ground. If the shoe sole is deformable, part of the power of the action will be used to deform the shoe, consequently reducing the power of reaction.

**4. LINEAL AND ANGULAR MOTION:** lineal motion is the movement that is done in a straight line, and consists of the transfer of weight.

**5. STRETCHY ENERGY:** the energy stored in the muscle, produced by the stretching that is made in the preparation for the hit phase. The muscle acts in an elastic way that stretches storing energy and releasing it in the impact

**6. KINETIC CHAIN:** each segment of the body is an important component in the success of the production of a stroke, from the ground to the wrist, going through the ankles, knees, legs, hip, trunk, shoulder, forearm, and wrist.

The generation of the hit is produced by the addition of actively coordinated segments that transfer the power generated from the ground into each segment, ending up in the final acceleration of the racket onto the ball.

In the observation of the transmission within segments in the kinetic chain, it is very important to detect if during the coordinative transmission of the power a delay or acceleration is produced, thus resulting in a poor production of the hit with a high probability of injury. It could be observed: omission of a part, wrong synchronization, lack of efficiency and/ or unnecessary use of power. Good observation allows increase the power, maximize the weight, delay the fatigue and avoid injuries.

When a player presents a deficiency in the production of a hit, it is important to identify if the factors that limit it are biomechanically correct and/or show limitations that have to do with the biotype or are part of the player preferences regarding their playing style.

**7. ACCELERATION LAW:** Apply power to the hit is not the same as acceleration, which is the variation of speed of the body. If it increases, it is positive; and if it decreases it is negative.

The power is and it is in the origin of acceleration (power is related to weight, not only of the individual but also of the element and its shape)

**8. FRICTION:** It allows us to jump, run, turn round, throw i.e. actions that depend in part on horizontal impulses against the ground (action and reaction) that give rise to actions of the same intensity but in the opposite direction.

It is produced by the contact of the foot with the ground or court floor, and it develops a transmission from the ground to the segments of the kinetic chain.

**9. LEVERS:** The motor system is formed by bones, joints, muscles and nerves. This system produces its movements through the muscular forces that are applied by a levers system, fundamental to do the sports movements.

“All that is lost in power is won in distance”

**10. CENTRIPETAL AND CENTRIFUGAL FORCES:** centrifugal force is the effort made to increase the rotation speed. It is not advantageous for the player, and of course it is not for squash either. The opposing force is centripetal.

**11. RHYTHM:** it is achieved when the hits have an impact sequence, a progressive movement in time with acceleration in the phase before the impact.

A player has a good rhythm when they have an excellent control during the whole hit, a transmission time upon the ball all the time, and rare impacts out of the centre.

### **Observation system. Changes in the way to teach squash.**

It is important to consider that the player learns through kinetic feelings, i.e. basically from what they feel; for that reason the exercises should have an objective that allows a sensory recognition of what we demand from them, when hitting the ball and achieving a good shot is not the only objective.

Part of the specific work on the formative movement area should be done, as it is of great importance for the future of the player especially when working with children.

Another point to consider is the qualitative work of each hit, seeking quality in each of the areas involved in the process, rather than on quantity. The same occurs in the movements/displacements, they should not aim to get just speed and physical strength but quality and the saving of energy. To run a lot in the court sometimes makes players win and get the best results, and it is generally the easiest way, the shortcut, especially with not very well trained coaches or with anxious parents who want immediate success in their children' playing squash; but we should insist on the most comprehensive way of playing, on developing more finished players.

**A FINISHED PLAYER** is the perfect combination of mind, technique, tactics/strategy, and body. Senti-pensante-actuante

*“Every hit is generated in the body by the use of leverage and physical laws, to be transmitted to the ball through a tool, the racket, during a time of contact, the impact. The wrist sometimes replaces this theory because of the speed of the game, but this situation should be minimised”*

**When a technical gesture is conditioned by the dynamics of the game**, the technique should be considered as the consequence of a tactic intention and not an end in itself. For this reason, a classical biomechanical analysis has a restricted character, oriented basically to understand the physical reasons and to develop theories of movement that will enable the coach to establish learning strategies and adequate physical conditions.

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Up to now, the coach observation is based on the comparison between a reference model, and their own experience, not only in the competitive field but also in their working or teaching experiences, and in general making a comparison with the mental image they have of the process.

**ACQUIRE:** this is the first stage in the learning, where the player relates to the new mobility skills for the first time. The teacher starts working in a scheme that represents the objective to achieve and which will enable to develop that skill.

**SECURE:** this is the specification, step by step, from global to specific coordination, in which the repetition from the mental model to the physical repetition takes place.

**STABILIZE:** the objective is consolidation, combining different situations aiming to achieve the proposed target.

**APPLY:** this is when the player acts unconsciously and in a repetitive way, and after having acquired a skill, they use it in different situations.

**Functional analysis:** is the one that checks the purposes and defines the optimal movements for the player to achieve an objective of better and successful performance.

**Optimal movement:** is a high level technique that enables the attainment of a successful hit respecting the player individuality (style) and being biomechanically the best.

**Motor learning:** improvement of the motor coordination. It consists of the organization of external and internal factors of conditioning, enabling the acquisition of behaviour techniques to adapt to a situation so that the player develops more skills.

***“Three aspects get together to achieve the best performance: hit at the right time and controlling the ball, not producing injuries”***

Visible squash: it is the cosmetics of the technical movement, the style.

Invisible squash: it is governed by the mechanical laws that rule the body behaviour, and these laws will allow primary coordination to better all the players motor skills.

It is a systematic way of analysis and observation of the mechanics of the human movement that makes the invisible technique visible.

In squash, the technique is based on the sequential coordination of long to short segments, and the transfer of energy, being the latter the most effective in short movements on small resilience.

At present, the understanding of physical laws and how they act upon our body movements and its segments, and what changes they produce, either in a good or in a bad way, enables us to understand the importance a good sequential time in the transfer of segments.

All in all, the hit from the racket is the result of a performance movement made up of many segments that, well coordinated, will have an optimal result in the hit, that is the final stage of the movement.

This system acts interrelating the qualitative observation of the movement with the technical-tactical objective (advance) and our philosophical- mental model (aggressive squash), and it is determined by the understanding of the laws, the training, and the experience of each coach.

When we analyse the hit, it is important to consider its strength and weakness, prioritizing what the effect of the corrections could be, and determining what the error is. It is also important to evaluate the effect in a short time, since excessive correction could paralyse the player considering that they can focus on just one correction at a time.

The hit from the whole shows us the way; the work in each segment should have a necessary pause to achieve the recognition of it and its interrelation with the other parts of the hit.

## ANALYSIS TO ESTABLISH THE REAL MODEL OF A PLAYER

### Philosophical model:

Apply the teaching philosophy of the Latin American School (comprehensive squash, technically and tactically aggressive)

### Tactic model:

It is important to take into account the personality traits of the player, analysing from the general to the specific; to cognitively develop the player to enhance understanding and enforcement of many strategic variables and tactics during a game, considering imposing their own model of player upon their rival, to then know how to adapt to them in case it is necessary.

It should also be taken into account the importance of each hit in the tactics, that the player is familiar with the area they are playing in and that they could easily move in each of them with good control of the hits (distance, effects, angles, power, direction, heights, control of the ball) and all the necessary variables.

*The player should learn to make the decisions that enable their evolution and maturation in the sport, and in their capacity as a human being.*

### Technical model:

It consists of applying all the basic technical concepts in the whole swing but taking into account how flexible one could be when working on the specific, and the personal traits of each player. We cannot produce robots, but we can be based on the technique as the fundamental foundation of the whole game.

### Mental model:

The player profile will be ready when they understand what their style of playing is like, what importance each of the hits has, and in this way they start building their own play features. It is

important to consider their biotype, their emotional aspect, the type of reactions under pressure, their ability to manage time in a match in order to determine their objectives.

Also, the player should learn to interpret their body sensations, i.e. their body language, and also to understand their rival's. This will enable them to be at an advantage in certain situations.

The player should also learn to resolve activation in case of loss of confidence, and to look for a relaxation system.

Activation, relaxation; visualization; rituals; positive dialogue; body language; error control; resolution of problems; re focus on a plan; development of concentration.

### **Determining factors for a good observation:**

- Establishing a philosophical model;
- Observation phases of each hit;
- Technical- tactic model;
- Establishment of physical biotype and biomechanical laws;
- Mental model

### **Remember:**

The way of looking should be changed, and it should be done analysing the movement starting in the floor, where the kinetic chain transmission force originates, from below upwards, from the big muscles to the small ones and in a synchronised way.

Based on an evaluation and taking into account the player's strengths and weaknesses, a system of objectives should be set in order to maximize their strengths and to teach them to resolve conflicts under pressure. A model built assuming weaknesses will help us make them less visible and then turn them into strengths.

The key to anticipation is to read, to look, to perceive. Within perception we should consider the reaction time, which is in relation with the time the brain takes to process the received information, and send the order of the decision made to the muscle. It is calculated that the response takes 381 to 803 thousands of a second.

Mobility time is the time it takes to be in a position. In emergency situations when there is little time and space, the players find it difficult to adopt a side face position against the lateral walls, so it is important to work on the perception and fast activation form the racket.

It is important the development of the decision making we dealt with above. Understanding that the process of decision making is a cognitive development, it is produced by selection of one of many alternative answers. There should be included in the process a recognition of a future position and

situation of the ball, according to the received information and the situation of the game. In conclusion, decision making entails a solution to problems and could be based on: already known answers, with variables; less built variables; and unknown variables.

**Learning cycle:** the coach constantly works on the formation and development of different capacities, in search of a cognitive model where the player can process the information in relation with the object, the opponent, time, space and their personal motivation.

We should look at the angular movement that the hip would make, which enables the acceleration of the shoulder, sending energy to the hitting arm.

It is important the previous work of leg movements, like little jumps that generate explosive outward power and transmission towards the impact, the work with the feet and the departure towards the ball in all the moves, with or without steps, once produced the decision to react. There should be control of the gravity centre moving in straight line, promoting lineal moment.

For balls far from the body, the specific work is given by the legs work, abdominals, spinal, and a firm hand.

### For later analysis:

Starting and recovery speed; agility; keep the sequential rhythm intensive for the hits; endurance in long intense matches; keep concentration, tension, and efficiency; and avoid injuries.

## **LATERALIZATION, SIMETRIC BASIS AND INFERIOR LIMBS MOTOR**

Bilateral equivalent motor represents an essential aspect in mobility on which to build later the asymmetric specialty, both in upper and lower limbs. However, regarding the latter, our sport needs, for a better technical performance and to avoid typical injuries, a symmetric lateralization of the lower limbs, and an asymmetric one for the upper limbs, as it is almost impossible to play with both hands in turn.

Lateralization of the lower limbs in relation with the lower ones depends not only on their nerve maturation, more belated, but also on the lower environmental requirements. The time of stabilization of laterality can therefore vary notably from pupil to pupil.

In the motor area, lateralization should not be accelerated because it is necessary that the child can experience situations demanding equivalent bilateral mobility.

It is extremely important that in the period of more development of the coordination capacities (7-12 years old) a complete evolution of this bilateral mobility is achieved, especially at lower limbs level, where there is the most frequent demand for cyclic movements, and consequently symmetric. Obviously, this demand is crucial if we transfer its action to the adaptive and acyclic displacement in squash. An early introduction, either from childhood or from the time an adult starts learning, to the asymmetric basis in the lower limbs will make it difficult and incomplete the learning of the other symmetric basis, going against an adequate technical performance and accelerating the injury process.

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The capacity to control the mobility of the limbs, apart from being attached to lateralization, it is to the sensible and motor representation of the distal part of the limbs. The imperfect control of the limb distal parts is frequently the origin of technical and control errors in the hits as well as in shifts. While for the hand there is a predominance of the motor representation (at cortical level), for feet it is more common the sensible representation than the motor one.

The foot has changed in the course of phylogenetic evolution going from a predominantly prehensile to an exclusively antigravity function. This represents a regression in the foot functions. The control of the distal part of the lower limb (beyond the knee) has become now just approximate for the stimuli that come in, so the consequent motor adaptations are very limited and stereotyped at present.

While the environment proposes in general an amount of stimuli enough for the hand and upper limb motor and sensible maturation, the distal parts of the lower limb –that already mature later- do not receive enough stimuli from the nervous point of view.

As a consequence, we frequently observe in squash players, both beginners and advanced, that their lower limbs know only the specific mobility of each basis, and above all, an asymmetric lateralization that aggravates the motor deficit.

It is important to improve the conscious control and the distal segment representation of the lower limb in the body scheme by means of active exercises, either in or out of the court.

A first objective is represented by the necessity to create, through an inductive method, an equivalent bilateral mobility, mainly in the lower limbs both in the fore-posterior and in the lateral direction. It is therefore necessary to pay special attention to the starting of displacements.

For the frontward displacement, starting always from a position of parallel feet and semi flexed knees, there should not be a backward motion of a foot; the first foot to move should move frontward and then initiate the displacement.

If the movement, however, starts with a foot in front and the other behind, situation that can often occur because of the speed of the game, the starting could begin by moving first the back foot forward, or else by doing first a small movement forward with the back foot to overcome inertia and give a better pushing angle to the lower limbs.

The transfer backwards, even biomechanically completely different from the transfers forward, presents, however, the same problems as regards the starting. It should be exercised to improve and stabilize the automatism.

The lateral transfers in short and medium steps, important in situation sports, need also great care on the part of the coach because when speed requirements increase, the pupils tend not to turn round after the first step, and hit the ball with the body head-on towards the fronton, not side facing, being in permanent imbalance, and losing equivalent bilateral mobility. Therefore, multiple adaptation problems are produced connected to new game situations and their correspondent specific displacements.

## SQUASH, AN OPTIMAL MOVEMENT

All the human beings develop in three areas interrelated with each other: the socio-affective-volitional scope; the cognitive scope; and the motor scope. These scopes are areas that when acting in a simultaneous and interrelated way determines the personality. Any change in one of the scopes will produce changes in the others.

It is in the motor scope that physical education acts, therefore it participates in the **integral and integrated formation** of the individual/ person. This participation is realized through its **OBJECT** of study that is the **MAN IN MOVEMENT**.

The formation is **integral** because the development in a scope affects the others, producing chained changes, positive or negative, in accord with how it is produced and, it is integrated because it interacts with the environment, depending on the socio- cultural and natural characteristics where it develops.

The maturation of the Central Nervous System and the amount of fortuitous and / or intentional and or conducted experiences that the individual has in the interaction with the environment will make them incorporate behaviours that will modify their proceeding, and which, associated with the previous experiences (motor memory), will enable modify and improve their environment and/ or make de necessary adjustments to adapt. This process of maturation is called learning.

This process involves the three scopes of conduct, therefore the learning the player incorporates in the motor scope, will involve the cognitive and the socio- affective- volitional areas, and at the same time, will modify both of them. Man, in a generic way, can be defined for this presentation's sake, and not getting involved in well known deep philosophical analysis, as "human being" characterized for its level of reasoning and abstract thought that allows modification and/ or change in conduct and environment for their own and their peers' benefit.

Human movement is defined as "the external, environmental component of the human activity that is expressed in the changes of the positions of the body and its parts, and in the interaction of mechanical forces between the organism and the environment." (Meinel-Schnabel, 1987)

Movement cannot be realized without motor processes and functions, what makes us define the term "human mobility" as "the whole of the processes and functions of the body and the psychic regulation that have as a consequence the human movement. A motor act represents:

- A component of an activity or regulated conduct way, consciously planned, whose result (objective) is mentally foreseen.
- A process conducted and regulated, based on the sensomotor regulation systems;
- A complexity of physiologic and biochemical processes (energetic processes) that provoke movement ("external") by means of the coordinated action of muscular contractions and relaxation.
- Changes of place of the body and / or its parts, i.e. movement from the mechanical point of view

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Movement, from another point of view, and summarizing and grouping the previous concepts, is integrated into the following components:

- 1. Movement core
- 2. Conditional capacities
- 3. Coordination capacities
- 4. The technique

“The concepts ‘movement’ and ‘mobility’ of the human being have consequently two aspects of the same phenomenon in the frame of the human activity, that in a certain way could refer to its external and internal aspects” (Meinel- Schnabel, 1987)

These aspects are regulated and controlled by complex neuromotor, sensorimotor, and physiological mechanisms, which we will call external regulation or adaptation mechanisms, and internal regulation or conduction mechanisms.

The relation and integration of the concepts of human movement and human mobility allow us to try to re define the object of study as:

***“Any motor action done with a determined intentionality and that represents an expression of the human behavior of the subject in a situation.” (Neumaier – Ritzdorf)***

As “ideal model of a movement that is wished to achieve, and that can be broken down into measurable characteristics (quantitative) and titratable in its coordination (qualitative)” (Grosser-Neumaier, 1987)

Effective procedure for the corporal action from a study of mobility, adapting it to the rules or regulations. It has to allow the maximum efficiency within the athlete’s (sportsperson) possibilities, and the medium in which they interact, as well as compare the model (nominal value) with the result of the action (real value)” (Schnabel)

Here we should understand and clearly differentiate the concepts of effectiveness and efficiency:

**Efficiency:** to achieve the planned motor objective with the required budget for the set situation.

**Effectiveness:** to achieve the planned motor objective with the minimal budget for the set situation.

Here we should clarify the concept of budget that is interpreted as the energetic requirements, the technical performance and the tactic application of the motor action selected for the solution of the raised situation, both in a task or in an exercise as a game / sport.

**The technique** as a component of movement is of great importance since it will allow an economy in effort in the realization of a motor action, not only a habitual but also a sports action.

Then we can say that optimal motion is:

***“Any motor action realized with a determined objective in order to solve a problematic situation in an efficient way.”***

## THE OPTION FROM THE COACH TO THE PLAYER

The basal effort is just the adequate to accomplish a task with less wear, neither too soft nor too strong, just the right effort. Whatever the task there is an optimal energy expenditure, a particular way to conduct the adequate musculature to that task. It is better that there is nothing superfluous, nothing redundant, and nothing contradictory in the action. It is enough to look at the squash court to see there the evidence of an overacting, basically not just waste but something counterproductive.

To be conscious of the excessive muscular tension may be of help to release it; sometimes an “avalanche” of realizing that is just enough not to break the “dam”, but it is not always like that. It is as if the trend is to “cling on being clung”; there is something in us, essentially conservative, that resists changes, even when the change is for something better. We are really reluctant to leave our miseries aside. The same happens in squash. It is unbelievable the obstinacy with which some students cling to their defects, even those who are happy with their progress in their lessons, still embrace their erratic ways, not willing to abandon their resistances.

If the teachers try to take away their students’ bad habits, they will have little success, it is as if a pacifier is taken from a baby, the solution will not last.

The bad habits in squash are just the most obvious part of an action system, of a complete set of answers, and it is the relationships within the system that need readjustment if changes are to last. The job of the teacher is to use their ability to see the whole process and not just the result, to discover exactly how their students have tangled the skein, and to lead the students in the discovery of their key weaknesses. The entanglement is then a task for both, teacher and student, to work together without unconscious competition. Their defects will disappear easily when they stop feeling they have to fight against their teacher because of their mistakes.

Re-enforcing the first concept, remember that for each action it is necessary the contraction of some muscles, but the bad habit makes us use more than what is necessary, and this is a waste of energy. It is like turning on all the lights in a house to read just a letter. The best is the most efficient and most economical.

When learning a skill it is important to determine what the relevant and the useless tensions are. This is important because the students will be practising a new skill and practice improves only what they are practising, not what they think they are rehearsing. If they do not see the difference, emphasising what is positive and avoiding what is unnecessary, it will be more difficult to separate useful tensions from useless ones, and this situation will make students feel at ease with incorrect habits, making it more difficult to correct them.

### **Remember:**

“When there is less effort, more subtle will be the differentiation in the response of our muscles, and more accurately we will make the effort fit the task.”

“The less effort we make, the faster is the learning of any skill, and the level of perfection we get goes hand in hand with the subtlety we achieve.”

“When tension is more optimal, differentiation is clearer, learning is easier and more precise”.

“Whatever you are doing, do less; switch off those lights you are not using.”

“Instead of piling up one strength on another, how much simpler it is to release resistance, to relax. Strength is yours, resistance is yours, the option is yours.”

## **COORDINATION CHAIN:**

The body segments that act as a system of shackles of the same chain, where the power that is generated by a shackle or part of the body is transferred to the following shackle successively.

## **SEGMENTS SEQUENCE:**

- Legs/ knees (flexion and extension)
- Hip / Flexo- extension and a very slight hit rotation
- Trunk/ Slight and controlled flexion and rotations of the trunk
- Arm / Shoulder /Rotation of arm from the shoulder
- Elbow / from flexion to extension at the moment of impact and returns to flexion at the end. Pronation.
- Wrist / Flexion of wrist

## **Coordination Chain problems:**

- Omit a part of the body
- Synchronization problems
- Inefficient use of parts of the body (wrong technique and displacements)
- Use of an unnecessary part of the body, wrist

## **INJURIES**

***“WHEN TRAINING, ANYTHING CAN BE DONE EXCEPT FROM PAYING THE CONSEQUENCES”***

The aim of this research is to prioritize the role of prevention and training in squash, maximizing the player’s performance in all levels and teaching them self care.

The objectives of this presentation are:

1. Know the prevalence of injuries in squash
2. Show the injury mechanisms
3. Relate injuries and their mechanisms with training deficits
4. Develop preventive guidelines

## **Injuries can be classified into two basic categories:**

**1-Traumatic injuries** that appear suddenly, which immediately show that something has gone wrong and whose effects are felt soon; these effects could be: pain, swelling, contusion or an open wound.

A traumatic injury can be **extrinsic** or due to an external cause, as a direct blow, a sudden twists when changing direction, or a fall. It can also be **intrinsic**, for no obvious reason, like the break of the Achilles tendon in the squash player.

**2- Injuries due to overuse.** These are more subtle because they show simply as an increase of pain, directly associated with a determined activity, usually repetitive. For example: tennis player's elbow.

The **injuries due to overuse** are sometimes produced because of overload or repetitive injuries in the skeletal muscle, where the tissues can bear heavy loads, but there exists a critical limit in this capacity that varies greatly from one player to another.

The age when injuries due to abuse are produced varies; they are more common among high performance athletes between 20 and 30 years old, and in the non competitive ones between 30 and 39 years old. As regards individual sports that require a precise technique, repetitive movements, and great speed like **squash**, an 80% of these injuries are produced mainly in the **lower limbs, especially in the hip, the spine and the knee.**

The abuse syndrome produces an overload in the tissues provoking an injury whose answer is an inflammation due to external pressures, friction or trauma.

### Frequent injuries in squash:

1. **Muscular contracture, distention, moderate sprain:** among the typical muscular groups are **cufflinks, soleus, anterior tibial, gluteal, anterior ischio-tibial, adductor, deltoid, supra sticleback, and wrist muscles.**

2. **Talalgia, Plantar fasciitis:** Produced by ill support plant and repetition of workloads with great impact.

3. **Tendon Injuries:** can be divided into brakages and inflammations. Approximately from 30 years old tendons start losing elasticity due to the degenerative changes, but the process can be delayed with regular exercise.

The inflammation in the tendons can produce a decrease in resistances and lead to a breakage even with normal loads.

Injuries in tendons are usually located in areas of little circulation, since the cells that produce inflammation cannot be removed in time and inflammation can persist to the point of fraying and later breakage of the tendon.

In the squash player tendinitis and the most common symptoms are mainly in the Achilles tendon, the patellar tendon, supra stickleback tendon, and wrist tendon.

**The Achilles tendon** is the most frequent case in players that is why we extend our study. It breaks 2.50 cm from the insertion in the calcaneum, where there is less vascularization.

The injury in the Achilles tendon can be caused by:

- Excessive use of the Achilles tendon because of tense muscles in the calf.
- Frequent tasks moving upwards
- Non progressive increase in the quantity and intensity of sport training, sometimes with shoes whose sole is little resistant to impact.
  
- Deformity in the position of the talon (hell varus- valgus)
  
- Repeated and prolonged work loads and become chronic.

**a. Acute inflammation of the Achilles tendon.** It is frequently produced in individuals who have not trained before and start training too much, and in those who train but change the surface or the type of shoe, or those who train in cold weather or do not warm up enough.

**b. Chronic inflammation of the Achilles tendon.** It is produced in players who have ignored the previous pain, and this pain at first tend to disappear after warming up exercises and therefore the player goes on training, but they come back after training. Gradually the pain becomes more severe to the point that it is impossible to continue with sport activity, leaving the player trapped in the pain cycle.

### Symptoms:

- 1) Pain, discomfort, stiffness in the Achilles tendon, before, during and after exercise.
- 2) Pain when walking or going up and down stairs
- 3) Pain to palpation
- 4) In case of persisting pain in the Achilles tendon, a partial breakage is likely, and a doctor should be seen.

**Chronic tendinitis** is a persistent process that is very difficult to treat, and it is essential that the pain in the tendon is considered an alarm signal and that inflammation is treated in the early phase.

**Breakage of the Achilles tendon:** The tendons start showing degenerative changes when players are between 25 and 30 years of age; these changes cause weakness in the tendons and they can be delayed with physical activity. Complete breakage of the Achilles tendon is likely to be produced in deteriorated tendons that have been exposed to great weight. The most affected players are those who restart activity after a brief of longer interruption of training activity, or those people who start an activity in order to keep fit abruptly.

4. **Sprains:** In the squash players they are frequent mainly in the ankles, sometimes because of stepping on another player, or for using the wrong shoes, for wrong displacement technique and for bad conditioning of the court floor.

**First grade sprain:** It is the result of ligaments distension. Swelling is minimal and the patient may start the activity in approximately two weeks.

**Second grade sprain:** The ligaments break partially with an immediate swelling; this is frequently related to repetitive previous injuries.

**Third grade sprain:** These involve the complete breakage of one or more ligaments, and they are frequently solved with surgery and immobilization of approximately four weeks.

- External sprain: (the most common) When the foot moves inwards.

- Internal sprain: When the foot moves outwards.

- Bilateral sprain: When the foot moves towards the plantar flexion, it is generally traumatic.

5. **Low back pain/ contraction:** A contraction can be produced by the search of low balls during the game, not performing a good lunge or as a result of an abrupt erection of the trunk not using the legs. The pain could not disappear and it could move to the lower limbs, producing a sciatic nerve irradiation, called lumbociatalgia. The majority of these episodes are produced in lumbar vertebrae L4, L5, and S1.

The iliac psoas muscle that bends the lumbar spine over the pelvis and stresses lumbar lordosis increases even more this deformity because of its hyper tonicity (this muscle is sometimes shortened in squash players)

When this happens, the sportsperson can feel strong lumbar pain because of an excessive tension exerted on the long portion over the lumbar insertion.

It is important to strengthen abdominals, ischio-tibial and adductors.

6. **Sciatic pain:** It is characterized by a persistent acute pain in all the area of sciatic nerve innervation (low back, hip and leg), in most cases with compression of it. The causes of sciatic pain in squash players have a progressive character, as they accumulate as years pass by, after traumatism (a fall or a blow), inflammation or arthrosis.

7. **Bursitis:** It is the inflammation of the bursa, bag shaped structure that is situated in between bones, tendons and muscles, and has a movement facilitating function of these structures with each other. It is present in all joints, especially in the shoulder, elbow, knee, hip, and ankle.

8. **Spondylosis and Spondylolisthesis:** Consists of a breakage of the lamina of the vertebra, in such a way that the joint is slightly separated from the rest. The most frequently affected vertebra is the 5<sup>th</sup> Lumbar, followed by the 4<sup>th</sup>.

The lumbo-sacral hinge made up of the 5<sup>th</sup> lumbar and the 1<sup>st</sup> sacrum represents the weak point in the spinal building. The sliding of L1 over S1 is called *spondylolisthesis*. When the isthmus between the L5 and S1 is broken or destroyed, there is *spondylosis*.

**9. Joint osteoarthritis or wasted joints:** It is the degeneration and excessive articular cartilage wear, provoking wear also in the bone that surrounds it, together with aging.

The articular surfaces are covered by cartilage, which does not have blood supply, and therefore cannot heal up when it is injured.

The cartilage acts reducing the friction between the bones, and then, when there is an abuse syndrome because of excessive physical activity, the constant friction and bounces produce a wear and it cannot be replaced.

The nutrients that the cartilage requires are provided by the synovial fluid that is secreted by the articular membrane that covers the joint capsule, and it also helps reduce the friction during the joint movements. This problem is found mainly in hips and knees.

The changes produced by osteoarthritis are irreversible, although different measures can be taken to improve the symptoms and delay degeneration. They are:

1) The load in the joint should be reduced and the physical form should be kept with cycling or swimming so that the joint does not work under pressure.

2) Active mobility exercises should be done, and also muscular strengthening.

This injury is related mainly with aging; however, metabolic, genetic, chemical and mechanical factors play an important role in its development.

### UPPER LIMB:

**10. Elbow: epicondylitis: the epicondyle** is the area where the fore arm muscles join the lateral elbow bone. The excessive use of these muscles occurs frequently in sports like tennis and squash, where extension and rotation of wrist and hand are performed, causing overstrain in extensors of wrist and less frequently in forearm supinator. Most of the injuries are related to the second radial (extender of wrist)

Epicondylitis can be caused by:

- Wrong impact point in backhand hit
- When power is not generated with legs, hips, trunk, shoulders.
- The muscle epicondylitis fix the joints (elbow, wrist) and power is not generated from there.
- Over use

The squash players that develop this process could inhibit during hits because they are afraid of starting pain again. They feel pain over the epicondyle when the hand is turned backwards (dorsiflexion) at wrist level when resilience.

11. **Shoulder:** injuries of the external rotator cuff, the most common within the supra tendon-stickleback injuries, sometimes causing subluxations and luxations in the humerus joint because of a complete injury in the external rotator cuff.

The **squash players** that develop this process could inhibit during hits because they are afraid of starting pain again. They feel pain over the picondyle when the hand is turned backwards (dorsiflexion) at wrist level when resilience.

12. **Wrist: tendinitis** due to inflammation of tendons in the wrist joint.

## CONCLUSIONS:

The following statistic data have been found from 2010 to 2013 (included) in the city of Buenos Aires, on a total of 600 players (570 amateur of all categories and 30 professionals).

- 45% injuries are cramps (29% lumbar; 15% gluteal area; 13% calfs; 11% *ischio-tibial*; 11% quadriceps; 9% cervical, 12% other)

- 50% of these cramps are situated in the trunk and 80% within muscles that are part of the posterior chain

- 22% tendinitis; 23% epitrocleitis/epicondilitis; 11% external rotator cuff; 10% wrist; 14% adductors; 11% Achilles; 8% ischio-tibial; 11% patellar; 12% other.

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- 15% sprains (56% ankle; 15% wrist; 12% knee; 16% other)

10% sprain (breakage) (32% adductors; 25% ischio-tibial; 21% calf; 22% other), and 90% of them are produced in the lower limbs.

- 8% other

- 60% injuries are in the lower limbs

## These percentages show:

1. A great demand in sports gestures in the lumbo-pelvic area, due to extreme efforts in flexion positions and an abuse of trunk rotations to reach low balls.

2. Training deficits (few or unspecific stimuli). This deficit is the result of wrong information and education both in players and their coaches.

3. Demonstrating eccentric requirements (braking and reaction) and relating it again with a poor conscience of a good flexibility or specific training.

4. Sprains: owing to the squash requirements (reaction, power and accuracy sport) it is shown the non- existence of proprioceptive training of the lower limbs and strengthening of the stabilizing muscles of the ankles , fundamental in the prevention work for this injury.
5. The presence of a great quantity of sprains is due to lack of plans for general or specific strengthening, flexibility and coordination.
6. The lunge positions to reach low balls are a great requirement for the ischio-tibials, quadriceps and lumbar.
7. Lateral movements (displacements) are sometimes very demanding (for the speed of the game) and influence on the adductors.
8. The movements/ displacements multidirectional with explosive brakes and starts, with the addition of jumps, completely overcharge the lower limbs.
9. Relating a deficient training with the injuries caused by the sport requirements, it is clear that the practice of squash in a bad physical condition leads to fatigue sooner, being this the main cause of technical and tactic errors, exposing the player to more possibilities of being injured.

### **INJURE PREVENTION:**

*“ To educate and make players aware , both amateurs and professionals, and above all coaches that are in charge of teaching children and young sportspeople and of training in squash, that there should be information and conscience of the mechanisms and processes of sanitary education for a healthier practice of squash, and training methods.”*

### **General and specific preventive aspects:**

- a- Warming up
- b- Joint flexibility and muscular elasticity
- c- Hydration
- d- Back to calm (regenerative work)
- e- Eating habits
- f- General and specific muscular strengthening for squash
- g- General and specific physical preparation for squash
- h. Adequate and in good conditions shoes
- i- Mouth health

j- Training of mental abilities

k- Physical/ medical check ups and evaluations

l- Foot support test

m- Proprioceptive work of feet and ankles

n- Management of the technique of squash: BASIC TECHNICAL CONCEPTS

o- Definition of a personal style of playing, as complete as possible, with tactic and strategic variables, that reduces the competitive stress and the excessive efforts in squash.

p- Style is necessary as long as it does not go beyond the limit of respecting the healthy technique of the sport

q- Training of the PERCEPTION AND PERIPHERIC VISION, reasons for bad displacements and excessive movements due to bad space-temporal orientation and the relationship with the object and the opponent.

### **CORE:**

This is the name given to the lumbo-pelvis complex and the hips, composed of approximately 35 muscles that work as stabilizers and/or mobilizers of bone levers to allow movement.

When the muscles are tired or out of state, the others automatically compensate the action and it then when a muscular or ligament injury appears, or there is an alteration of the sport performance.

In squash, explosive forward movements are made, as well as lateral and backward ones (with diagonal combinations) while the ball is hit. If the CORE power is not strong enough there will be a lumbo- pelvic instability that will not allow an optimal explosive power.

Abdominal muscles play a fundamental role in the CORE structure, but if they are subjected to strengthening without training the lumbar spine muscles and the trunk lateral ones, muscular imbalance can be developed causing most of the sports injuries.

A strong and stable CORE can develop an optimal performance of the lower limbs and allow the athlete to develop more speed and resistance, optimizing the performance and reducing the number of injuries.

The spine should be stabilized by working the deep musculature.

*Front deep muscles:*

- Diaphragm, major psoas, and pelvic floor.

*Deep posterior muscles:*

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- The rachis multifidus, Transverse abdominal, internal oblique, Transverse and Interspine, Quadratus lumborum (illiotransverse fibres), Long and illeocostal dorsal (lumbar portion)

## *Superficial muscles*

- Major rectum of the abdomen, external oblique, dorsi, and lumbar square (remaining fibres)

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Post Grado en Licenciatura Entrenamiento Deportivo y Alto Rendimiento (U.B.A.)

## CURSOS DE LA ESPECIALIDAD

- Entrenador Nacional de Squash Grado I; II y III Nivel Avanzado (Squash Rackets Association. (Paul Wright y Graham Stevenson)
- Entrenador Nacional de Squash Grado I y II Squash Canadá (Stuart Dixon)

## PARTICIPACIÓN EN CURSOS Y CONGRESOS

- Participante en el Congreso Mundial de Coaching y Desarrollo del Squash, Hong Kong, Mayo 1998, organizado por la W.S.F.
- Participante en el Congreso Mundial de Coaching y Desarrollo del Squash, Río de Janeiro, Octubre 2000 (W.S.F.)

## EXPERIENCIA LABORAL

### **Entrenador Selecciones Nacionales Argentinas:**

- Selección Femenina Mayores 1993/95 (Panamericanos Medellín 1994, 4° puesto y Mar del Plata 1995, 4° puesto)
- Selección Masculina Mayores 1994/97 (Panamericanos Mar del Plata 1995 con Medalla de Plata; Medellín 1996 con medalla de Oro) Campeonato Mundial Egipto 1995, 13° lugar. Marcas nunca superadas hasta ahora.

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- Selección Masculina Juvenil 1994/96 y Mundial Sub 19 Italia 2000 (Campeonato Mundial New Zeland 1994, 11° lugar y 18° lugar en Italia)

## **Entrenador de selecciones nacionales de otros países:**

- Entrenador Selecciones Nacionales del Ecuador, Torneo Panamericano, El Salvador 2001 (6° puesto, mejor marca histórica para el país)
- Entrenador Selecciones Nacionales de El Salvador en el Panamericano de Ecuador 2002 (6° puesto, mejor marca histórica del país)
- Entrenador Selecciones Nacionales de Chile, febrero-mayo de 2004
- Coach de la bicampeona sudamericana de mayores, la chilena Loreto Barriga Castro, 2004 y 2005
- Head Coach selección Chilena Mayores 2004 (Panamericano Tepic, México. 5to puesto en damas y 8° en Varones, ambas mejores marcas históricas de Chile)
- Entrenador Selecciones Juveniles de Costa Rica en Abierto Junior Guatemala 2008 y Selecciones Mayores periodo 2008 a 2009

## **CURSOS DICTADOS**

- Instructor y Entrenadores Nacionales Grado I, Neuquén, Argentina, Septiembre de 2000.
- Instructor y Entrenadores Nacionales Grado I, Buenos Aires, Noviembre de 2000.
- Instructor y Entrenadores Nacionales Grado I, Quito, Ecuador, Julio 2001.
- Conferencia sobre Desarrollo Deportivo, El Salvador, Octubre 2001.
- Instructor y Entrenadores Nacionales Grado I, San Salvador, El Salvador, Marzo 2002
- Instructor y Entrenadores Nacionales Grado I, Cundinamarca; Bogotá y Medellín, Colombia, Mayo y Junio 2002.
- Entrenadores Nacionales Grado II, Cundinamarca, Bogotá y Medellín, Colombia, Octubre 2002.
- Instructor y Entrenadores Nacionales Grado I y Grado II, Buenos Aires, Octubre y Noviembre 2003.
- Instructor y Entrenadores Nacionales Grado I y Grado II, Santiago, Chile, Marzo-Abril de 2004
- Instructor y Entrenadores Nacionales Grado I, Concepción, Chile, Abril 2004.
- Conferencia sobre Iniciación Deportiva, Country Club Prince of Wales, Santiago de Chile, Abril 2004
- Instructor y Entrenador Grado I y Grado II, Quito, Ecuador, Julio 2006.
- Instructor y Entrenador Nacional Grado I y Grado II, Ambato, Ecuador, Agosto 2006.
- Instructor y Entrenador Nacional Grado I, Guayaquil, Ecuador, Agosto 2006.
- Instructor y Grados I, II y III, Bogota, Colombia, Octubre 2007

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- Instructor y Grado I, Lima, Perú, Noviembre 2007
- Instructor y Grado I, San José, Costa Rica, Diciembre 2007
- Instructor y Grados I, II y III, Córdoba, Argentina, Diciembre 2008
- Entrenador Grado I, II y III, Quito, Ecuador, junio 2009
- Entrenador Grado I, Mendoza, Argentina, Marzo 2010.
- Entrenador Grado I, Salta, Argentina, Mayo 2010.
- Entrenador Grado I, Mar del Plata, Argentina, Marzo/Abril 2011/12 y Buenos Aires y Bogota en 2013.
- A la actualidad ha capacitado a mas de 310 Profesores y Entrenadores de todo el continente, aproximadamente un 76% de todos los que trabajan en Latinoamérica.
- Campus de enseñanza y entrenamiento para menores y juveniles, desde el año 2008 en Argentina y Ecuador.

### OTROS CARGOS

- Miembro de la FED. Panamericana de Squash, Comité de Coaching y Desarrollo Deportivo 1996/2002
- Coordinador Nacional de Desarrollo Deportivo 1999/01 (A.A.S.R. y Secretaria de Deportes de la Nación)
- Autor del Programa Nacional de Menores y Escuela Nacional de Menores, 1996.
- Autor del Programa Nacional “Plan Capacitar”. 1997. Aprobado y reconocido por la Secretaria de Deportes de Argentina y próximo a ser reconocido por su calidad educativa y trayectoria por la W.S F.
- Creador de la “Escuela Latinoamericana de Squash”: Visión-Filosofía-Concepto-Sistema, que cuenta ya con 9 sedes en todo el continente.
- Director de los Programas de Desarrollo Deportivo de Ecuador, 2001
- Director de los Programas Nacionales de Desarrollo Deportivo de El Salvador y Colombia año 2002
- Director del Programa Plan Capacitar y Desarrollo Deportivo Nacional, Chile 2004.
- Director del Programa Plan Capacitar y Desarrollo Deportivo Nacional, Costa Rica, 2008
- Gerente de Deportes del Costa Rica Tennis Club, San José, 2008 a 2009
- Director del Programa de Desarrollo de la Unión Argentina de Jugadores de Squash.
- Director y organizador del campus de entrenamiento mas grande de Latinoamérica, agosto 2010, Mar del Plata, Argentina, ya en su tercera edición.
- Representante de 10 universidades americanas para la detección de talentos deportivos aspirantes a becas universitarias.
- Director del LATINOAMERICA SQUASH JUNIOR TEAM y del LATINOAMERICA PROFESIONAL SQUASH TEAM
- Director Académico y Fundador de la INTERNATIONAL SQUASH UNIVERSITY

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- Editor de la revista Squashglobal
- Catedrático virtual en [www.cybersquash.com.mx](http://www.cybersquash.com.mx)
- Fundador del primer sistema de e-learning para capacitación y formación de entrenadores internacionales de squash.
- Presidente de la Fundación Un mejor Squash es Posible.

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### **Lic. Diego Garcia**

Specialist in kinesiology and rehabilitation

### **Lic. Cristian Cofre Bolados**

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University of Rosario 1990.

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## Bibliography and collaborators

Tomo 1 y 2 Monografías médico-quirúrgicos del aparato locomotor basado en la formación de la secot (sociedad española cirugía ort y traumat) Dr. Enrique Caceres Palau y Dr. Raimon Sanmarti sala. Sociedad española de Reumatología.

Proafi (programa actividad física) entrenamiento /deportivo con orientación en ortopedia y traumatología. Dr. Sergio Luscher

American College of Sport .Medicine 1988/2009

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Instituto de Rehabilitación y Kinesiología con Capacitación permanente para el Entrenamiento Deportivo en Jugadores Amateus y Profesionales con Rutinas Personalizadas.  
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