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New Training Frontiers in Golf

Considerations from a neurosurgical perspective

Eyad Al Kahlout[1], Walter Bini[2]

Neurosurgical Department and Spine Center

Duisburg, Germany

Abstract

Background: Golf, a sport gaining popularity globally, poses unique risks to musculoskeletal health, particularly among older players. The repetitive nature of the golf swing and inadequate athletic preparation often lead to injuries, especially in the spine, shoulders, and elbows. This study explores the biomechanics of golf and evaluates innovative training methodologies to mitigate injury risks and enhance performance.

Materials and Methodology: The study integrates insights from sports science, neurosurgical assessments, and physical therapy to analyze common injury mechanisms in golf. Data from a comprehensive literature review, including clinical case studies and injury prevalence surveys, were combined with biomechanical evaluations. Modern training approaches such as the Gyrotonic Expansion System, MFT Proprioceptive Tables, and elastic resistance training were examined for their efficacy in improving flexibility, strength, and injury prevention.

Results: Findings highlight that injury risk peaks during the downswing and impact phases of the golf swing due to high muscular loads and sudden force application. Older golfers exhibit higher injury rates, attributed to age-related physiological changes such as reduced spinal flexibility and muscle strength. Implementing structured training programs significantly reduced injury incidences and enhanced golfers' biomechanical efficiency. Techniques like Gyrotonic and Body Blade improved spinal mobility and neuromuscular control, while MFT tables optimized balance and coordination.

Conclusion: Proper athletic preparation tailored to golfers' needs, incorporating multidisciplinary evaluations and advanced training systems, can mitigate injury risks and prolong active participation in the sport. Integrating these strategies, particularly for older players, enhances both safety and performance, underscoring the need for wider adoption in golf training protocols.

Keywords: Golf Biomechanics, Athletic Preparation, Injury Prevention, Aging and Sports Performance, Advanced Training Systems.

Introduction

The sport of Golf is rapidly expanding and attracting more and more people who find it difficult to resist the temptation to hit the magic white ball. This enthusiasm, however, can lead to and be related to an increase in problems related to our musculoskeletal structure. Statistics show that in relation to other popular sports, Golf tends to attract older people who, due to predispositions and physiological changes, are more at risk of injury, mainly in the lumbar region of the spine and beyond.

This evolution has been observed daily at international centers specializing in conservative spine treatments like ours.

The game of Golf combines anatomically undisputed principles, such as high compressive forces combined with lateral flexions of the spine, which could negatively affect it, generating physiological alterations. Intuitively, a well-trained back from a muscular point of view can significantly reduce the risk of injury. In most cases, the golfer hits the ball, underestimating the importance of these compressive forces, which could sometimes seriously compromise his physical integrity (19). An appropriate warm-up must become an essential part of the game. Simply walking at a brisk pace to reach the green facilitates blood circulation to the muscle groups, preparing them for exercises to be performed before the game or match begins.

The Golf Swing

How can the swing motion increase injury risk?

Sports physicians and athletic trainers agree to divide the swing movement into five distinct phases. All this emphasizes the excessive load our musculoskeletal structure supports during each single phase. (4) We could easily list a multitude of risk factors, but identifying precise causes of injury is still a subject of study given the complexity of Golf's athletic activity. (8)

However, by consulting recent literature, we can assert that excessive tension at the muscle-tendon level, rigidity, sudden twisting movements, and accidental impacts with the head of the wood on the ground exponentially increase the risk of injury. (11)

The Address Phase

The Address phase is considered to be the phase in which the body is subjected to the least functional stress compared to other phases of the swing.

During this phase, the weight of the body is equally distributed on the lower limbs, more precisely on the two feet. The latter lie parallel on the ground, spaced as much as the width of the shoulders. The spine is tilted forward so as to form a right angle of 90° with the wood.

The knees are relaxed and slightly bent forward to center the body weight distribution on both feet.

The arms are extended and relaxed. The address phase itself is not particularly stressful for the body, but an inadequate grip and stance can lead to injuries in the later phases of the swing.

The Backswing Phase

During the Backswing phase, the head of the wood reaches the highest point of the swing. The weight of the body is transferred to the right leg with a movement that involves the rotation of the hips, knees, shoulders, and spine. Despite the rotations, the head remains relatively still. Considering that

When the head of the wood reaches its maximum height, there is a verticalization of the left thumb and of the two wrists, resulting in an intense stretching of the forearm muscles.

The repetition of this gesture, commonly called "Backswing," can lead to numerous problems such as tendonitis, wrist and elbow, shoulder impingement syndromes, and spinal injuries, mainly in the lumbar region. In the Backswing phase, approximately 20% of all injuries occur compared to other phases of the swing. (12)

The Downswing Phase

In the Downswing phase, the body weight is transferred to the left leg, more precisely to the left foot, while the knees, hips, and trunk rotate to the left. In this phase, there is a vigorous muscular intervention by the oblique abdominal and spinal muscles, which are responsible for the rotation of the trunk. If we wanted to quantify the extent of their muscular intervention, we could assert that it is three times greater than the intervention that occurs during the Backswing phase. It should be noted that the muscles of the right shoulder (rotator cuff) and the left pectoral are stressed in the downswing phase 8 times more than in the Backswing phase. Therefore, such a high intervention by

these muscles is required, which allows the head of the wood to accelerate up to a speed of over 160 km/h.

The repetition of this gesture can give rise to numerous problems, such as inflammation of the wrist and elbow muscle-tendon structures, stress fractures of the ribs, and strains of the chest, abdomen, and spine muscles. The frequency of injury compared to the backswing phase is twice as high. (13)

The Impact Phase

In the impact phase, the head of the wood hits the ball, or at least that is what is desirable. The wrists and hands complete the acceleration phase of the wood by assisting an overlapping and rotating movement of the right hand with respect to the left immediately after the ball is hit. The impact force that is generated by hitting the ball is transmitted to the body in an upward manner through the wood. In order to overcome this impact force, the muscles must contract vigorously to allow the wood to continue on the desired trajectory. However, if an object on the ground, such as a stone or simply the ground itself, were accidentally hit, a very high counterforce would be generated that would prevent the wood from advancing and would increase the risk of injury to the nerves of the hand due to excessive compression at the wrist level. Furthermore, this would also lead to a high risk of injury to the muscle-tendon structures of the elbow, shoulder, and spine, thus exacerbating the pain from degenerative arthrosis often localized at the hips and knees. At this stage, the greatest number of golf injuries occur (20).

Follow-Through Phase

After hitting the ball, the wood gradually slows down. In this follow-through phase, the trunk rotates to the left. The wrists rotate over each other, creating the roll-over movement. The shoulders and hips continue to rotate until the body is aligned toward its target. The back hyperextends, and the body weight is completely transferred to the left side. As in the other phases of the swing, there is an injury rate of 1 in 4 that primarily involves the articulation of the ankles, knees, and hips. Finally, we recall the susceptibility of injury to the spine, mainly in the lumbar region. (1)

Golf and Seniors

Golf is unique in its ability to attract older people to the sport. We could say that Golf represents one of the largest growth segments in the elderly population. Just think that in the United States, over 6 million players are over 50 years old. (14)

Understandably, this carries a greater risk of injury.

A recent study on a sample of 1000 amateur golfers revealed that the risk of injury increases significantly in players over 50 (65% injury rate) compared to players under 50 (58% injury rate). (2)

Not only are older people more susceptible to injury while playing, but they are also more susceptible to ailments and disorders that do not arise directly from Golf but that nevertheless compromise performance and enjoyment of the game.

- Occasional back pain was reported by 52% of golfers with an average age of 50 years
- Knee pain was reported by 12% of golfers with an average age of 55
- Hip problems were reported by 9% of golfers with an average age of 62
- Elbow problems were reported by 8% of golfers with an average age of 41

This should not come as a surprise since each of us brings with us our own physiological changes as we age. (3).

Physiological changes in old age: nervous system, heart, muscular system, osteoarticular system

Although poorly understood, the aging process negatively impacts each of our body systems. As we reported above when talking about the older golfer, we can add that he is at greater risk of injury and requires longer healing times to return to Golf. Below, we will briefly describe each of the systems that are most affected by the aging process. (21)

The nervous system: as time passes, the brain's functional capacity decreases, establishing a slight atrophy of its functional parts due to reduced blood flow. This also reduces the number of available neurotransmitters that will slow down the speed of the nervous impulse, slowing down the reaction times of a subject by **20%** compared to another younger one.

The heart: between the ages of 30 and 70, we see a significant reduction in cardiac output, which decreases by up to **30%**. With aging, the heart loses its muscle mass, and the remaining muscle fibers have a reduced contractile capacity. (14)

T**he Muscular System:** Throughout our lives, we see a progressive reduction in lean muscle mass and an increase in fat mass. Both the number and size of our muscle fibers decrease with age. By the age of eighty, our overall muscle mass is reduced by **30%**, resulting in a reduction in muscle strength of 50%.

The osteo-articular system: as the years go by, our osteo-articular system also undergoes substantial changes. The joints reduce their mobility by up to **30%**, the cartilage lining the joint surfaces thins, and the bone mineral mass is reduced. All this leads to a lower capacity to support functional load stress and to increase the risk of degenerative diseases recognizable as osteoarthritis. In some cases, the cartilage is reduced to the point of causing excruciating pain when the bones come into contact. As regards the loss of bone mineral mass, we can see that it is twice as high in women as in men. Last but not least, we report perhaps the most dramatic osteoarticular change that occurs in our body during aging. We are talking about the intervertebral discs that, over the years, experience a loss of water from the gelatinous nucleus, which will thus compromise its "sponge" capacity to exchange nutrients and make it unable to adequately absorb stressful loads. All this limits lumbar torsion in the older golfer, which is reduced by **50%** compared to younger golfers. (11).

Athletic Preparation in Golf:

The fear of losing flexibility and decreasing one's performance with training is considered unjustified for not undertaking a specific golf training program. It has been scientifically proven that by following a specific golf training program, we do not worsen our performance but rather protect it so that it can remain at high levels for a longer period of time (17).

A golfer's athletic preparation cannot be compared in intensity or duration to that of a runner who is about to run a marathon. However, it must be kept in mind that from the downswing phase to the moment.

The wood can reach a speed that exceeds 160 km/h in just two-tenths of a second of the impact with the ball. From this, we deduce that even if the swing itself does not require a high degree of strength, it undoubtedly requires high speed, coordination, and the involvement of many muscles that intervene simultaneously during the athletic gesture. We also remember that usually, during a golf course, at least 50-60 swings are performed without including the practice swings, and approximately 8 km are covered, equivalent to an energy expenditure of approximately 1000 calories (16).

The current **modern-day golf prep program** is undoubtedly a significant proof of how important proper athletic preparation is for the golfer. Although pros professional golfers participate in more competitions in a year than we do in our entire lives, their athletic preparation is a fundamental part of the game. It is no coincidence that the **PGA** provides highly qualified personnel qualified spaces and structures where the golfer is followed during training sessions.

Strength Increase

Strength in Golf allows us to accelerate the swing of the wood until it reaches a high speed at the moment of impact with the ball, allowing us to execute very long drives. To the question of which muscles are most activated during the swing phase, we can specify by listing the most important muscles below:

- shoulder muscles are known as the rotator cuff on both sides, stabilizing muscles of the scapula such as the trapezius, levator scapulae, rhomboid, and serratus anterior
- the pectoral and back muscles are considered key muscles in generating power during the downswing phase
- the erector spinae muscles, the oblique abdominal muscles, which are particularly active during the beginning of the forward swing and subsequent acceleration phase
- the gluteal muscles, hamstrings, hips, and thighs whose contribution in the swing phase is erroneously underestimated
- the extensor and flexor muscles of the forearms, which provide a firm grip and, at the same time, ensure the stability of the wood at the moment of impact with the ball (7)

Improved Flexibility

Our muscles and joints have physiological limits.

If subjected to continuous stress beyond a tolerance threshold, we could incur a muscle-tendon strain in the best of cases.

Appropriate preventive training of muscle-tendon stretching that improves the joints' mobility and the muscles' extensibility would guarantee us a lower functional load over time that would better respect the physiological excursion of the osteo-muscular structures repeatedly stressed during the swing phase. Researchers report that there is a substantial difference regarding the flexibility and mobility of the spine between professional and amateur golfers. They also highlight that by improving the mobility of the trunk and the spine, amateur golfers would improve their swing as well as significantly reduce the risk of injury (15)

Some important concepts to keep in mind regarding stretching to improve flexibility:

- stretching should be performed after warming up the muscles and tendons with a light aerobic activity, for example, 5-10 minutes of slow jogging or fast walking
- the stretch should be performed slowly and held for about 30-40 seconds, avoiding bouncing and trying not to go beyond the physiological limit of stretching, recognizable by a sensation of sharp pain.
- it is recommended to start the stretching sessions slowly and to gradually increase the stretching from time to time without exaggerating

Aerobic Conditioning

By definition, we consider physical activity any discipline that allows us to generate aerobic conditioning through an increase in heart rate up to 75% of the maximum threshold and that is maintained for a period of time not less than 20 minutes. Usually, the weekly training periodicity is three times. The cardiac training target varies with the age of the subject (16)

Among the most common aerobic activities are jogging, walking, cycling, swimming, etc. (18). Before starting any type of physical activity, a good rule is to have a medical check-up. The most suitable program for amateur golfers should include a set of specific exercises with a progressive degree of intensity that develop strength, resistance, and mobility of the joints and extensibility of the muscles involved in Golf. Appropriate training has many benefits, such as:

- Improves body composition by increasing lean mass and reducing fat mass
- Improve your performance
- Improve blood pressure, glucose, and cholesterol control
- Improve muscle flexibility
- Improve muscle strength and thus increase wood speed

New Frontiers Of Golf Training: Top Physio Athletic Preparation

To play Golf well and safely, adequate athletic preparation is recommended to ensure the best athletic condition, an essential prerequisite for improving one's performance and significantly reducing the risk of injury. We can talk about new training frontiers thanks to the experience gained with athletes from Golf and other amateur and competitive sports disciplines during more than 30 years of practice that have allowed the top physio sport concept to establish itself at the highest

level as a team approach including a detailed neurosurgical evaluation and control in a multidisciplinary approach together with physiotherapists.

Gyrotonic Expansion System

The Gyrotonic expansion system is an exercise system that stimulates the joints through physiological movements without creating compressions within them, strengthening tendons and ligaments. Gyrotonic uses key principles of dance, yoga, tai-chi, swimming, and gentle gymnastics, making the various muscle groups functional, integrated, and interdependent. Each exercise is performed through spiral movements, allowing those who perform them to have constant and conscious control over their movement. A uniform and gradual resistance concentrated on the joint axes generates centripetal and centrifugal forces on the muscles involved, which are distributed in synergy between the various agonist, antagonist, and synergistic muscle groups. Gyrotonic uses a series of equipment specifically designed to respect individual freedom of movement, speed, and versatility. The exercises are synchronized and correspond to a specific breathing rhythm that generates a delicate or vigorous cardiovascular stimulus depending on the intensity of the training and the type of exercise. In particular, on the spinal column, Gyrotonic acts by increasing functional capacities, with a consequent better balance of the upper part of the body (trunk) with respect to the pelvis, which, through a rocking movement, acts as an "anchor" and "pivot" also for the lower part (lower limbs).

It follows that the numerous harmful stresses for the spine and micro-traumas are attenuated, giving the body flexibility and greater resistance, which leads to autonomous and dynamic postural control (9)

MFT Multifunctional Proprioceptive Tables

The main muscles must be controlled and trained appropriately for their functionality. We are used to sitting from childhood to old age. Therefore, muscles, tendons, and ligaments are not sufficiently stressed, failing to safeguard joints and the skeletal system. The result obtained with correct training through the use of the MFT proprioceptive multifunctional tables is the prevention of all injuries that could occur in various situations in sports and in everyday life.

The spine needs both stability and mobility, and MFT effectively addresses both. MFT boards are excellent for therapy and rehabilitation, as they offer the treating physician a systematic training method to speed up the healing process. At the same time, the patient exercises in a pleasant way (Dr. Stippler). Training with MFT discs leads to a higher quality of training in both amateur and professional sports. In almost all sports, training to achieve good coordination is very important for achieving better performance. It follows that the receptors of the muscles and the corresponding

tendons and joints must be adequately exercised. MFT proprioceptive boards are unique in the therapeutic exercise equipment market due to their modular system. (Dr. Christian Raschner, sports scientist, universities of Innsbruck and Salzburg), (5)

Theraband Elastic Resistances

Muscle strengthening training or improving physical resistance through the use of elastic resistance has been recognized as an important part of any training program. It is no coincidence that the American College of Sports Medicine recommends training at least twice a week for both young and old people.

Theraband elastic resistances have been used in the fitness field for over a hundred years. However, despite their undisputed effectiveness and adaptability, in the last 25 years, they have been used mainly in rehabilitation in order to regain strength and complete autonomy following an injury. Furthermore, nowadays, they also receive wide approval in athletic training. Given their versatility, they adapt perfectly to any sporting discipline, including the game of Golf (10).

Body Blade

The creator of the Body Blade was an American physiotherapist named Bruce Hymanson. Mr. Hymanson sought to create a movement regimen that could train the deep muscles responsible for correct posture without subjecting the joints to excessive functional loads. We can train the neuromuscular system responsible for motor control through the Body Blade. The benefits are joint mobility, flexibility, posture, and coordination, excluding joint wear. By varying the position of the body or the direction of the blades, we are able to train specific muscles. Research has shown that training with the Body Blade improves the individual's ability to reproduce joint movement more accurately and repetitively. Since it can be used at any angle and position, the body blade can mimic the movement of a particular sport and provide the specific training required (6).

The Top Physio Golf Concept

The Top Physio Golf Concept was born from the need to create a training program that allows us to train the functional anatomical structures of our body simultaneously and adequately. Using the methods mentioned above, which are considered irreplaceable but integrable with each other, we have been able to achieve surprising therapeutic results. Specifically, I am referring to conservative treatments of the spine using Gyrotonic, improved balance and proprioception thanks to the use of multifunctional MFT tables, functional re-education and muscle strengthening through training with elastic resistances Theraband and finally, certainly not in order of importance, improvements in tone

of the deep muscles of the shoulder and spine using the Body Blade. Thanks to careful research and the proven experience of our operators, it was possible to plan the Top Physio Golf Concept, which is capable of improving the golfer's performance and, above all, preventing injuries.

Medical Visit:

The first step to frame the patient is the medical examination, performed in the context of a medical check-up but including a detailed evaluation by the spine specialist. It must be accurate and detailed because it is essential for therapeutic purposes. The patient's age, sex, profession, family history of diseases, symptoms (acute and chronic), onset, pain (onset, location, characteristics), and objective examination must be evaluated, which in the specific case of the golfer must take into account how he walks, moves, flexes and rotates his torso; the internal organs must be palpated, the cardiovascular and respiratory systems must be assessed, the muscles and neurological reflexes must be tested and finally any diagnostic tests performed must be reviewed.

Postural Assessment:

Adopting a correct posture is a good habit that contributes to a person's well-being. There are several definitions of posture, and in my opinion, the most appropriate is "the somatic expression of the human relational attitude with one's interiority and with the environment that surrounds him." Having said that, the evaluation of postural alignment must include a standard. The ideal posture involves a minimum amount of tension and contracture and, above all, leads to maximum efficiency of the body. Therefore, the standard requires that the spine has normal sagittal curves (cervical lordosis, dorsal kyphosis, lumbar lordosis) and that the bones of the lower limbs have an alignment that supports the body's weight. In an upright position, a plumb line is used as a reference line with respect to which imaginary lines and planes are measured to study the anatomical positions of the body. The frontal reference line must pass through the spinous process.

From a lateral point of view, the postural reference line passes through the external auditory meatus, the odontoid process of the axis, the bodies of the lumbar vertebrae, slightly anterior to the tibial axis and lateral malleolus up to the calcaneal cuboid joint. For this postural evaluation and also for the controls, a non-invasive spine check is available and can be carried out by us using the IDIAG M360 pro Spinal Evaluation System.

Osteopathic Approach:

Osteopathy refers to that complex of organic, functional, and structural dysfunctions that involve the musculoskeletal system in the form of myofascial tension and, therefore, cause altered postural alignment.

Structure and function are interdependent, meaning that the shape of a given structure is directly influenced by the functionality of that anatomical part and the organs it contains.
Therefore, it is essential for the therapist to identify those dysfunctions deriving from various causes (iatrogenic, exogenous, vascular, etc.) that limit the freedom of movement of the bone joints, muscle bands, and serous membranes:

The osteopath traces, reasoning anatomically, the area of injury, discriminating the painful area from the true origin of the functional alteration, which is very often not painful

The approach must make use of specific mobility tests, and in particular, in golfers, it will be necessary to take into account the neuromuscular balance of the pelvis and the spinal column, and in this regard, the standing and sitting flexion tests, the Patrick test and the Downing test are indispensable.

Physiotherapy:
Osteopathy is a manual form of medicine; therefore, treatment is carried out through techniques that require the use of the hands, particularly through direct manipulation and/or muscle energy techniques.

In daily practice, artificially produced physical means are used, particularly those that produce heat energy, electric currents, and electromagnetic waves, although movement therapy remains increasingly important.

We distinguish physical means that produce heat exogenously from infrared lamps to hyperthermia, means that produce electromagnetic waves from lasers to magnetotherapy: currents of variable frequency from galvanic to tens ultrasounds that produce mechanical vibrations, and finally, recent therapies that use endogenous energies produced by our organism. Movement therapy is fundamental, with all its rehabilitative implications, to be associated with the use, when necessary, of physical means. Therefore, the figure of the trainer-rehabilitator is of considerable importance because he is the one who guides the patient in functional recovery and in improving his sporting performance.

We have obtained ongoing beneficial results through our concept of a multi and interdisciplinary evaluation, care, and approach for the screening, improved preparation, treatment, and controls for

the person practicing Golf based on our dedication and daily work with spinal conditions, both conservative as well as surgical. The intention of this article was to raise awareness of the importance of a proper approach to avoiding unnecessary musculo-ligamentary, joint, and spine lesions in Golf.

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