Sports biomechanics and functional anatomy

Introduction:

Biomechanics is the sport science field that applies the laws of mechanics and physics to human performance, in order to gain a greater understanding of performance in athletic events through modelling, simulation and measurement (Wood, 2009). According to Mcginnis, (2004), Biomechanics is useful to sports and can identify what forces may have caused an injury, how to prevent the injury from recurring and what exercises may assist for injury rehabilitation. It can be used for alternations in technique, equipment or training to prevent or rehabilitate injury. The general role of Biomechanics is to understand the mechanical cause-effect relationships that determine the motions of living organisms. In relation to sport, Biomechanics contributes to the description, explanation, and prediction of the mechanical aspects of human exercise, sport and play. Sports biomechanics offers methods by which the very fast actions which occur in sport can be recorded and analysed in detail. An important application of sports biomechanics with any sport is the definition and understanding of skills. This can help in the coaching process and as a result enhance the learning and performance of those skills (Reilly and Williams, 2003).

When looking at golf it is clear to see a lot of skill is involved during the swing. Hung and Jani, (2004) stated that the golf swing is one of the most complex biomechanical motions a human can make in sport. The aim of the golfer must be to make a consistent strike of the ball to propel it in the desired direction for a given distance. Furthermore the hip plays an important role in the golf swing.

The Hip joint:

The hip joint is one of the largest and most stable joints in the body. It is a ball and socket joint that consists of the head of the femur connecting with the acetabulum of the pelvic girdle. The pelvic girdle, including the hip joint plays an important role in the supporting the weight of the body while offering mobility by increasing the range of motion in the lower extremity. The acetabulum is the concave surface of the ball and socket joint, facing anteriorly, laterally and inferiorly. Furthermore the spherical head of the femur fits snugly into the acetabular cavity, giving the joint both congruency and a large surface. Both the femoral head and the acetabulum have large amounts of spongy trabecular bone that facilitates the distribution of the forces absorbed by the hip joint (Floyd and Thompson, 2001; Nordin and Frankel 2001; Uys, 2004).

Ligaments of the hip:

According to Callaghan et al, (2006) several strong ligaments reinforce the capsule of the hip joint. These include the iliofermoral ligament, the pubofemoral ligament and the ischiofemoral ligament. The iliofemoral ligament is the strongest ligament in the body and helps to prevent extension of the femur when the body is standing erect. It is a Y-shaped band of very strong fibres that connects the lower front iliac spine of the coxal bone to a bony line (intertrochanteric line) extending between the greater and lesser trochanters of the femur. However the pubofemoral ligament extends between the upper portion of the pubis and the iliofemoral ligament. Its fibres also blend with the fibres of the joint capsule of the hip joint. The ischiofemoral ligament is made up of a band of strong fibres that

originate on the ischium just behind the acetabulum. These fibres blend with the fibres' of the joint capsule of the hip. (Pickering, 2009)

Muscles of the Hip:

The muscles of the hip joint are those muscles that cause movement in the hip. Most modern anatomists define 17 of these muscles, although some additional muscles may sometimes be considered (Mind Body Motion, 2007). These are often divided into several groups. These muscles control the movements of the hips. According to Özkaya et al, (1999) the psoas, iliacus, rectus femoris, pectineus and tensor fascia latae are the primary hip flexors. These are also used to carry out activities such as running, walking and kicking. The gluteus maximus and the hamstring muscles are hip extensors. The gluteus medius and gluteus minimus are hip abductor muscles providing for the inward rotation of the femur. The gluteus medius is also the primary muscle group stabilizing the pelvis in the frontal plane. The adductor longus, adductor brevis, adductor magus and gracilis muscles are the hip adductors and also provide for the outward rotation of the femur.

Movement of the hips:

The hip joint allows for the greatest range of movement as it has the capacity to move in three planes, about three axes. It also has a great deal of mobility, which allows normal locomotion in the performance of daily activities. Kolt and Mackler, (2003), state that the hip joint has three degrees of freedom of motion which include flexion-extension in the sagittal plane, abduction-adduction in the frontal plane (figure 3. 2) and external-internal rotation in the transverse plane.

Golf

The modern golf swing has evolved with this use of technology, both in equipment and analysis; as well as the physical training the golfers now go through. The golf swing is a very complex body motion, involving a large range of movement of the upper limbs that act as a link between the golf club and the body, with the lower limbs acting as the main movement promoting areas. Limitations in the body in terms of flexibility, muscular strength, endurance, or power can create faults in the swing from a biomechanical perspective. As a result, most of the successful golfers in the world today, are relatively fit, flexible and strong compared to in the older generation of golfers. Improved technology in gyms has given golfers the opportunity to strengthen specific and key muscles used in the swing.

Hip rotation is very important to the effectiveness of the golf swing. According to Hill, (2007), it holds the key to a powerful swing. To increase power and ball-striking ability the hips need to rotate properly during the swing. According to Atherton,(2009), most amateur golfers rotate their hips too far during the backswing, which makes it difficult for them to get their hips to open up to the target at impact, a key component of a successful swing. However, the increased risk of hip injury is a relatively recent hazard for golfers, arising from the greater rotation favoured by the modern golf swing. This adaptation of this technique itself reduced the incidence of low-back injury among golfers.

The downswing begins with a forward movement of the hips that, with good golfers, actually begins approximately 0. 1 seconds before the club head reaches the limit of the back swing. This moving forward of the hips rotates

the whole upper body and moves both levers through the first part of the downswing (Hay, 1993). The forces responsible for this forward movement of the hips and the lesser forces exerted by the same hip and leg muscles later in the downswing have been estimated to account for 2. 5 hp of the total 3-4 hp generated in a good drive. Thus it can readily be seen that the muscles of the hips and legs constitute the main source. A series of EMG studies have described the role of the hip muscles during the golf swing (Thain and Alistair, 2002).

A study by Tsai et al, (2004), showed that hip abduction strength was significantly higher in better golfers. In addition it stated all the hip movements tended to be stronger in the best golfers who had the lowest handicaps and longest driving distances.

In one study performed by the University of Umea in which the muscle activities in 13 male professionals while performing a golf swing were analysed using dynamic surface electromyography (EMG) and the muscle activities were measured in percent of maximum manual muscle testing (MMT) of each muscle. During the forward swing, gluteus maximus, expressed the highest muscle activity during a complete golf swing (84%). This indicates that especially the trailing side, gluteus maximus, is an important hip stabiliser as the golfer shifts the weight to the target side and the golf club begins to accelerate (Grinell, 1999). In golf the hip is especially exposed to high-velocity internal rotation on the downswing, requiring a great deal of eccentric gluteus muscle control.

Set-up, ball positon, alignment and posture are essential for a good swing. However according Shamus, (2001), the most common characteristic of an improper setup position is failing to use a hip-hinge motion to obtain the primary spine angle. Furthermore evolved technology has made it easier for golfers and coaches to analyse the golf swing and correct mistakes made by the golfer.

Technology advances: (ASTAR and Powerstool)

The Astar digital video technology is the latest, highly sophisticated software that evaluates and analyses recorded golf swings. This means that golf instructors can literally capture and illustrate every aspect of a student's swing to determine and remedy any problem areas. It automatically creates a video file of the entire desire motion (for a golf swing from address to follow-through). Astar includes all necessary functionality to analyze technical performance, hence improve the golf swing by this method of analysis. By using the very latest A Star professional software, golf swings can be analysed from many different angles and a plan can be put in place for the improvement of any golf swing (ASTAR, 2006).

The powerstool is another example of advanced technology used to improve the golf swing. It mimics the perfect golf swing as close as possible enabling the golfer to get inot the most efficent position (Strachan, 2009). The powerstool makes sure the golfer achieves the right amount of hip turn and shoulder turn. This helps to reduce tension and strain that is common with over turning.

Technology in footwear and insoles has also developed throughout the years making golf shoes more comfortable and blister free. It has also been proven that specific golf shoes reduce injuries of the lower extremities. In addition, according to Light, (2008), the use of custom foot orthoses to change the mechanics of foot function may improve hip extension and create prolonged relief of low back pain symptoms. As a result, they provide a viable alternative to surgery to treat hip and back painmaking it pain free for golfers. Orthoses are also helpful for supporting the arch of the foot, offloading specific pressure points in the foot, and cushioning the heel. Furthermore it was claimed that orthoses could be a non-invasive approach to improving biomechanics and possibly pain.

ECCO golf, (2009) states that their golf shoes use a double-layer inlay sole that ingeniously absorbs heel force, reducing the impact felt by your knees, hip and back. That same heel force is also used to power an air-circulation system that ensures a fresh, dry and cool environment for your feet making it comfortable for the golfer.

In conclusion, it is clear to see that technology is evolving a rapid rate with new advances in biomechanical parameters. Advances in analysis and equipment has been proven to improve general performance of all sports and even holds an important role in reducing injury and the rehabilitation of injury.