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Editorial

Meniscal Suture- From Past to Future

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Introduction

Understanding the structure and function of the meniscus has been increasing in the recent decades thanks to extensive research activity that has contributed to the knowledge that the structure of the meniscus is more than a muscular remnant shaping as a crescent moon which lacking a role as described by Bland Sutton in 1897 [1]. The structure of the meniscus is a crescent shape. There are 2 menisci in the knee joint, internal and external, which is sitting between the femoral condyles and the tibialarticular surface and cover up to 2/3 of its surface. Its components are made up of 70% water and the rest is organic matter, mostly collagen type 1 (75%), GAG molecule (17%), DNA, adhesion glycoproteins and elastin [2-4].

The dimensions of the medial meniscus are not the same as the lateral one. The length of the lateral meniscus ranges from 32.4 to 35.7 mm and is 26.6 to 29.3 mm wide compared to the medial meniscus between which is 40.5 and 45.5 mm in length and 27 mm wide [5-6]. Although they have crescent structures, the lateral meniscus exhibits a greater change in thickness and has significantly higher level of mobilization compared to the medial meniscus as well as the extensive coverage of the lateral tibial articular surface (75% -93%) compared to the narrow coverage of the medial tibial articular surface (51% 74%) [7].

The meniscus grip to the articular surface is made by a number of supporting ligaments. The main ligaments are the medial collateral ligament, the transverse ligament, and the meniscofemoral ligament, known as Humphrey and Wrisberg, which connect the posterior horn of the lateral meniscus close to the posterior cruciate ligament on the medial femoral condyle. Although they are important ligaments and stabilizerson the back region, only 46% of the population will have the 2 ligaments and 100% will have at least one of them [8].

Blood supply is an important factor contributing the decision to treat a meniscal injury. Shortly after birth, the meniscus, which had full direct blood supply, is replaced by a vascular plexus in a synovial fluid close to the meniscus (parameniscal vascular plexus) originate from the medial and lateral genicular arteries surrounding the knee joint. Those arteries feed the 2/3 inner meniscus in the form of diffusion. Only 1/3 external meniscus (10%-30% of the medial meniscus and 10% -25% of the lateral meniscus) is nourished by direct blood supply of those arteries [9].

The area of the meniscus is divided into three parts according to the areas of blood supply - an external area, the red-red zone - which presents the direct blood supply by the genicular arteries, an internal area, the white-white zone - presents the lack of direct blood supply but by diffusion, and an interval area, red-white zone - characterized by a combination of the two.

The Meniscal Functions: A major advance in understanding the main roles of meniscus has been done in recent decades, making the meniscus from the status of "filling tissue" to its importance today. The main functions of the meniscus are absorption and transfer of forces from the femur to the tibia, load distribution, shock absorbers, joint lubrication tissue and nourished source to the joint environment. In addition, the meniscus play an important role in stabilizing the knee, which includes the proprioceptive sensing system, as well as appropriate structural adjustment between the joint parts thanks to the unique structure mentioned above.

The strength mapping of the meniscus was studied and showed that although the meniscus covers about 60% of the joint surface, its ability to transfer the force is approximately 50% of the axial load applied to the joint in extension [10]. During full flexion the lateral meniscus passes 100% of the load, while the medial meniscus passes only 50% of the load [11]. Evidence of the change in the passage of forces and the distribution of loads were also examined in studies after full meniscectomy and partial removal of the meniscus, and demonstrated that a partial excision of the meniscus causes an increase of up to 350% in the load [12-13], whereas complete removal of the meniscus causes a decrease in the tibiofemoral surface area, which express in increasing load of up to 2-3 times [14].

Meniscal injuries: meniscal injuries are most common injury among intra articular knee injuries [15]. Most of the damage is due

to the various forces that apply on it, especially rotation, hyperextension and higher loads applied on it [16].

The injuries can be divided into two main groups - severe tears and bruises characteristic of young populations and degenerative tears caused by prolonged wear, advanced age and structural changes characteristic of the populations from the fourth decade of life. The classification of the vulnerability depends on the location, thickness and stability of the meniscus. The tears are usually divided according to the painterly outline, such as a longitudinal, horizontal, diagonal, radial, complex, and bucket handle. It is possible continue to classify each tear according to the thickness of the injury that indicates a partial or complete rupture, which also can be classified as stable or unstable [17-18].

Treatment: The classification of the injuries is the index by which the treatment nature and effectiveness is determined. The reversal treatments in meniscal tears have changed in the recent decades. In the past it was accepted to remove the damaged meniscus and by this contribute to the decrease pain and return to activity but over the time, severe arthritic changes in the knee joint were observed which was in a direct relation to the meniscus fragment that was removed [19]. With the improved understanding of the structure and efficacy of the meniscus, the method for partial removal of the meniscus was proposed in 1982 [20].

About 20 years after the first operation performed for partial meniscectomy and in addition to the central role played by the meniscus in the various procedures of the joint, the recognition and trend regarding the preservation as much as possible and suturing the meniscus has increased. Open meniscal repair was first performed in 1883 by Annandale, but the main milestone was in 1969, when the meniscus was first corrected with the arthroscopic procedure by Hiroshi Ikeuchiin Tokyo. The documentation of Ikeuchi led to a great interest in techniques for preservation of the meniscus [21]. Various techniques for repairing the meniscus were developed over time, from an open method to the arthroscopic method. The equipment was also developed in order to facilitate the repair.

The common technique for suturing meniscus, for many years, was an "inside-out" method, which resulted in a 60% to 80% cure rate in isolated ruptures and up to 90% in ruptures associated with an anterior cruciate ligament rupture [22-24]. The second generation of suturing techniques was introduced by Russel Warren in 1985. This "outside-in" method was developed to reduce the risk of neurovascular injury, mainly damage to the peroneal nerve during lateral meniscus repair, and the saphenous nerve during medial meniscus repair [25]. The long surgical times, as well as the need to use additional posterior incisions, led to the invention of a new generation of repairs, the "all-inside" method, which is now accepted. This method was first described by Morgan [26-27], Mulhollan [28], and Reigel [29] for repair of tears in the posterior horn of the meniscus, and was necessary transfer of arched sutures from the back of the knee region by an additional cannulas [30].

Types of suturing: The meniscal darts (Bionx, Blue Bell, PA) was the first generation of meniscal suturing. Due to high demand technical procedure and the danger for the neurovascular bundle it was abundant. The second generation was the T-Fix (Smith & Nephew, Andover, MA). It was the first common suture in the "all-inside" technique. This method used with the standard arthroscopic incisions. The RAPIDLOC (Depuy Synthes, Westwood MA) offers the same function as the previous one but with higher flexible option for fixation. This method contains one posterior anchor located beyond the outer surface of the meniscus. The suture consists of three main components: the posterior anchor, the Etibond suture number 2, and the clamping. The suture is inserted into the knee on top of a gun that shoots the anchor from the inside part of the meniscus, through the tear to the knee capsule. The danger was the same as the first one- injury to the neurovascular bundle.

Due to moderate success, the third generation was made using the bio absorbable devices through various methods as arrows, screws, and devices designed to anchor the torn meniscus to the periphery of the knee. The disadvantage of these methods lies in the damage caused to cartilage when repairing the meniscus by the hard instrument. The fourth generation which is the current method was developed to solve the possible injury to the neurovascular bundle on the one hand and chondral injury on the other hand.

The fourth and more modern generation of the "all-inside" method includes products that are very common in the existing technique. These products are constructed from a combination of suture, sliding link, and peripheral anchor [31]. The Fas T-Fix (Smith & Nephew) and OMNISPAN (Depuy Synthes) suture consist of two anchors in a single entrance through a portal and their anchorage location beyond the peripheral surface of the meniscus on both sides of the rupture, followed by a sliding link between the anchors which thereby tightening the rupture.

Other technique is done by CETERIX (Orthopedics) suture which is a circumferential compression suture. This provides reduction and uniform compression of the injured meniscus. In conclusion, the attitude for the meniscus was changed during the years and now we know that it has big contribution in any aspect of the knee joint. This recognition gave rise to arthroscopic suturing methods in order to preserve the menisci structure and by this the knee function.

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