Hip Anatomy

35

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The hip is a ball and socket joint and is a diarthrodial joint formed by the head and neck of the femur and the acetabulum which represents the joint cavity. The articular surfaces of the femoral head and of the acetabulum are both covered by cartilage. According to Li et al. [1], average cartilage thickness on the femoral side and on the acetabular side is, respectively, 0.94 mm and 1.1 mm.

The head of the femur is connected to the femur trough the femoral neck and precisely through the head–neck junction. The angle between the femur shaft and the neck is 125 ± 5°. The femoral neck also has a 15–20° anti-version from the femur shaft.

The angle formed by the femoral neck axis and a line that goes from the center of the femoral head to a point where the contour of the femoral head-neck junction exceeds the radius of the femoral head is called alfa angle and is of primary importance to define a CAM morphology. An angle >55° is considered to be pathological [2].

The acetabulum is formed by the innominate bone that is the union of three bones, the ilium, the ischium, and the pubis. These three bones represent, respectively, 40%, 40%, and 20% of the acetabular surface and before their fusion are separated by the triradiate cartilage. As described by Santori and Villar [3] in a small percentage of adults, a groove named ileopubic groove can be seen in the acetabular surface, and this might represent an incomplete fusion of the triradiate cartilage (Fig. 35.1). The entire acetabular surface is covered by cartilage except for the acetabula fossa which is a non-articular area in the medial part of the acetabulum. This fossa is filled with a fat pad covered by synovial tissue. In some patients, a small area of the acetabular articular surface might have cartilage which is less thick than normal. This area is named stellate crease [3].

In some patients, an additional fossa might be seen in high resolution MRI. This fossa is named supra-acetabular fossa and is located at the 12:00

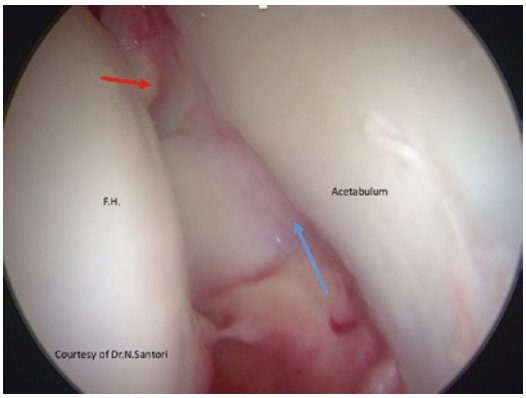

Fig. 35.1 FH: femoral head. Blue arrow: ileopubic groove. Red arrow: acetabular labrum

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position. This fossa doesn't have a pathological meaning and must not be confused with a chondral defect [4].

35.1 Vascularization of the Hip

Vascularization of the hip is provided by the so-called ring circulation that provides a blood supply to the bone and to the soft tissue structures.

The major blood supply is granted by the superior and the inferior gluteal arteries originates from the internal iliac artery and supported by the medial and the lateral circumflex arteries and their branches. The medial circumflex arteries originate from the common femoral artery while the lateral circumflex arteries originates from the deep femoral artery. Both the common and the deep femoral arteries originate from the extern iliac artery. Grose et al. [5] demonstrated the anastomosis of these four vessels which occurs in the cruciate anastomosis. These connections may have a protective role towards vascular pathologies.

The first perforating branch of the deep femoral artery flows under the quadratus femoris muscle and gives a branch to this muscle, then creates an anastomosis with the medial femoral circumflex artery just behind the short rotators, and then moves deep, bringing blood supply to the capsule, the labrum, and the hip. After having created these anastomoses, it runs proximally and reaches the gluteal vessels completing the so-called cruciate anastomosis.

The superior gluteal artery moves under the gluteus minimus and the tensor fascia lata and reaches the lateral femoral circumflex artery anteriorly. These vessels form retinacular and perforating branches that give blood supply to the capsule, the labrum, and the acetabulum.

35.2 The Labrum

The rim of the of the acetabulum is covered by the acetabular labrum (Fig. 35.2). This fibrocartilaginous structure along with the transverse acetabular ligament, which is attached to the walls of the acetabular notch, surround the acetabulum. Together, these two structures form a basket that surrounds the femoral head over its equatorial line. Due to its conformation, the labrum seals the joint fluid between the cartilage layers of the femoral head and of the acetabulum [6].

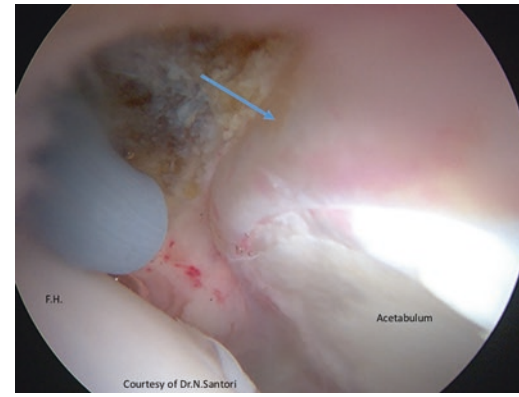

Fig. 35.2 Blue arrow shows an arthroscopic view of the acetabular labrum

The labrum has a triangular section, on the articular side it continues with the articular cartilage through the chondro-labral junction while on the capsular side it continues with the acetabular bone.

It has three differently arranged collagen layers, the first in which fibers have a random orientation, the second in which the fibers are arranged in bundles that intersect each other with variable angles and the third layer in which the fibers have a circular orientation. The collagen fibers also show a different orientation in the anterior and in the posterior labrum [7].

The collagen fibers of the anterior labrum are parallel to those of the acetabular bony edge, while on the posterior labrum the collagen fibers are perpendicular to those of the acetabular bony edge. This different fiber configuration is the reason why the anterior labrum is more frequently involved in lesions compared to the posterior labrum which is more resistant to share forces.

The labrum has a peculiar vascularization that was described by Kelly in 2005 [8]. Considering this vascularization, the labrum was divided by Kelly in two zones and in sub-zones. The half of

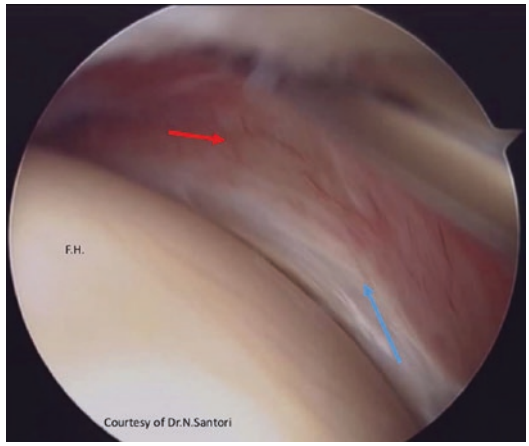

Fig. 35.3 Out in view of the hip. FH: femoral head. Blue arrow: acetabular labrum. Red arrow: peripheral vascularization of the labrum

the labrum on the capsular side is Zone 1 and the half on the articular side is Zone 2 (Fig. 35.3).

Zone 1 is divided into Zone 1A which is the peripheral part of the labrum on the capsular side and Zone 1B which is the part of the labrum on the capsular side closest to the acetabular bony rim. Zone 1B receives its blood supply from the bone which is the main source of labral circulation while Zone 1A is supplied by the capsular circulation.

Zone 2 is divided into Zone 2A which receives the same vascular circulation of Zone 1A and Zone 2B which is the part of the labrum which is closest and connected to the articular cartilage and is relatively an avascular zone.

35.3 The Ligamentus Teres

The ligamentus teres is a robust ligament and according to recent anatomic studies performed by Mikula et al. [9], it has six insertion zones on the acetabular side and a single one on the femoral side. The six insertion zones on the acetabulum are: the ischiatic insertion, the pubic insertion, the iliac insertion, the two margins of the acetabular notch and the transverse acetabular ligament. Its structure can be divided into three layers, an external one of synovial tissue, an intermediate one of loose connective tissue and a deeper one consisting of dense bundles of collagen tissue. Both in the intermediate and in the deepest layer, there are vessels and nerve endings, including the Pacini corpuscles. The dense presence of vessels in the foveal portion suggests a "nourishing" role of the round ligament also in adults. From a biomechanical point of view, its resistance is comparable to that of the anterior cruciate ligament of the knee. The round ligament has been shown to contribute to hip stability in flexion and extra-rotation, in extension and intra-rotation and in flexion and abduction. This occurs especially in cases of reduced capsule-ligament stability and reduced bone stability. In addition to the stabilizing role, Gray and Villar have proposed a role of the ligament in the distribution and circulation of the synovial fluid in the joint (windshield effect) [10].

35.4 The Capsule Ligaments

The hip joint capsule is reinforced by three longitudinal ligaments, the iliofemoral ligament, the ischiofemoral ligament, and the pubofemoral ligament. These three ligaments have a primary role in hip joint stability. The iliofemoral ligament has an inverted Y shape where the lateral and distal insertions are on the femoral intertrochanteric line while the proximal insertion is on the anterior inferior iliac spine. This ligament is also called the Bigelow ligament. The role of this ligament is to reinforce the capsule during external rotation and extension.

The ischiofemoral ligament has its insertion on the ischium, postero inferiorly to the acetabular rim and on the posterior intertrochanteric line. Its role is to reinforce the capsule during internal rotation in a neutral position and in a combination of flexion, adduction, and internal rotation.

The pubofemoral ligament has its insertion in the superior pubic ramus and converges on the femur with the medial portion of the iliofemoral ligament and the inferior part of the ischiofemoral ligament. Its role is to reinforce the capsule in abduction and in external rotation during extension.

A secondary role in capsular reinforcement and in increasing joint stability is played by the circular fibers of the zona orbicularis which forms a collar around the femoral neck. During hip extension, the zona orbicularis increases the stability of the femoral head anteriorly, while during flexion the zona orbicularis increases the stability of the femoral head posteriorly.

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