



An index of inguinal and inguinofemoral masses in women: Critical considerations for diagnosis

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ABSTRACT

A range of masses can manifest in the region encompassing the femoral triangle and the inguinal canal in women. These groin masses can be classified as being neoplasms, infectious or inflammatory processes, vascular conditions, as well as congenital abnormalities. Such inguinal masses can cause aching and pain sensations in the groin region, which can worsen after prolonged activity. A comprehensive history and physical examination are sufficient in making a diagnosis of the type of inguinal mass. Imaging modalities such as computed tomography, ultrasonography, or magnetic resonance imaging demonstrate a better understanding of local anatomical characteristics of the inguinal area, allowing for a diagnosis and the characterization of the groin pathologic conditions. Most inguinal masses are often repaired or need surgical intervention through open or laparoscopic technique. A combination of the clinical history, anatomical classification, and unique imaging features can aid clinicians in an accurate diagnosis of the inguinal or inguinofemoral mass in the female groin region.

1. Introduction

Inguinal masses in women are rare entities, located in the groin area where the upper leg meets with the lower part of the abdomen. The swelling is generally confined to a small area and can be portrayed as hard, soft, sensitive, or not painful at all. Typically, the presence of a groin mass is considered as an indication of an overlying pathological process taking place in a woman's body, emphasizing the criticality of a correct and timely diagnosis. Groin masses are located within or outside the inguinal canal as well as above or below the inguinal ligament. To enhance the evaluation and management of groin masses in females, there are several ways to classify these instances of swelling: (1) congenital abnormalities, non-congenital hernias, vascular conditions, infectious conditions, inflammatory conditions, neoplastic conditions, or iatrogenic conditions (e.g., femoral artery catheterization), (2) cystic, solid, or complex groin masses, and (3) location at, above, or below the inguinal ligament. The shape and appearance of groin masses depend upon the cause, which may be infectious, inflammatory, or allergic. Presently, this review focuses on outlining the female groin anatomy, as knowledge of it is essential for understanding the natural history of the mass. We also describe masses of the groin and inguinal canal, with the

inguinal ligament as a reference point. We intend to facilitate the clinical importance, evaluation, and management of groin masses that gynecologists, urologists, general surgeons, radiologist, and pathologists may encounter in their clinical practice.

2. An overview of the embryology and anatomy of the female groin

Groin masses can occur both below and above the inguinal ligament located in the femoral area of the body, in the inguinal canal, or in both the femoral and inguinal area.

2.1. Inguinal canal

The inguinal canal is an area of weakness in the abdominal wall and is often the site of origin of an inguinal hernia. It is a passage that is roughly 4 cm long in the anterior abdominal wall, which traverses the spermatic cord in men and the round ligament of females, from the uterus to the labium majus [1]. The external and internal obliques and the transversus abdominis muscles line the inguinal canal, with the inguinal ligament (*i.e.*, Poupart's ligament) lining the floor. Normally,

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men have larger and a more prominent inguinal canal than women. The surface marking of the inguinal canal constitutes a horizontal line that extends from the anterior superior iliac spine to the lateral margin of the rectus abdominis muscle [2].

The inguinal canal contains ends at the deep and superficial inguinal rings. It extends from the deep inguinal ring in the fascia transversalis that forms the posterior wall to the superficial inguinal ring in external oblique muscle that forms the anterior wall of the inguinal canal [3]. The deep inguinal ring is approximately 1 cm superior to the inguinal ligament and found lateral to the inferior epigastric vessels [4]. More specifically, it is above the inguinal ligament, midway between the anterior superior iliac spine and the pubic symphysis, and lateral to the inferior epigastric blood vessels. The deep inguinal ring is an oval gap within the transversalis fascia. The superficial inguinal ring is a triangular opening in the aponeurosis of the external oblique muscle located right above and medial to the pubic tubercle. The anterior wall of the inguinal canal is created by the aponeurosis of the external and internal oblique muscles; the posterior wall is created by the transversalis fascia and the conjoint tendon; the superior wall is created by the internal oblique and transversus abdominis muscles; the inferior wall is created by the superior surface of the inguinal ligament. The round ligament of the uterus and the ilioinguinal nerve to the labia majora [4,5] pass through the inguinal canal in women, along with the genital branch of the genitofemoral nerve, which provides sensory innervation to the mons pubis and labia majora. These constituents, along with the respective blood vessels and lymphatics, must be handled with special care during the repair of an inguinal hernia [6,8].

The inguinal canal can be described as being an outpouching of the peritoneum, which is a peritoneal diverticulum referred to as the processus vaginalis. In both males and females, the development of the gonads must descend into the pelvic cavity originating from the lumbar region of the posterior abdominal wall [7]. During the seventh week of embryonic life, the gonads are attached to the posterior abdominal wall. By the fifteenth week, the female gonads have descended down into the greater pelvis.

The development of the inguinal canal in females initiates when mesenchymal cells form the fibrous cord of tissue called gubernaculum cascades down both sides originating from the caudal ends of the gonads and attaches the ovaries to the uterus and to the future labia majora. The gubernaculum in both males and females, when attached to the gonads, terminates in between the internal and external abdominal oblique muscles, with females exhibiting swelling in the labial region. Unlike the testis in males during the seventh month, the uterus and the ovaries are both attached to the gubernaculum, preventing descent. Rather, the gubernaculum develops into the ovarian ligament and the round ligament, with the latter extending into the labia majora. To accompany the gubernaculum, pouching of the peritoneum into the labium majora is classified as the canal of Nuck.

2.2. Femoral triangle

Understanding the anatomy of the femoral triangle is crucial for femoral hernias, a type of inguinal hernia. The femoral triangle is located in the anterior area of the thigh and is surrounded by the inguinal ligament and medially by the medial border of the adductor longus muscle. The floor of the femoral triangle is formed medially by the pectineus muscle and laterally by the iliopsoas muscle, while the roof is formed by the fascia lata, a deep fascia of the thigh that encloses the thigh muscles and forms the outer limit of the fascial compartment of the thigh. The femoral triangle contains the femoral vein, femoral artery, and femoral nerve. In addition, the femoral artery is located at the mid-inguinal point, a point midway between the pubic symphysis and the anterior superior iliac spine, with the femoral vein located medially.

2.3. Roles of the gubernaculum, round ligament, and processus vaginalis

The inguinal canal is characterized as a tubular structure that runs inferomedially containing the round ligament, genital branch of genitofemoral nerve, and lymphatic vessels. There are numerous ligaments that are attached to the uterus. The embryonic structure, the female gubernaculum, role is to give rise to the uterine round ligament essential in the Müllerian development [9]. The gubernaculum in females is known to elongate in proportion with the enlarging abdominal cavity [8]. The ovary in the pelvis is intact due to the growth of both the uterus and the broad ligament; rather its connection to the inguinal canal is indirect via the gubernaculum. More specifically, the upper gubernaculum forms the ovarian ligament, while the lower gubernaculum forms the round ligament of the uterus. The round ligament develops from the inframüllerian caudal portion of the female gubernaculum. The supramüllerian (upper cranial) portion develops into the ovarian ligament. The elevation of the covering peritoneum by the mesonephros provokes the formation of the female gubernaculum from the caudal fold initiated by an extension of a cord from the gonadal ridge to the future inguinal region. The female gubernaculum consists of mesenchymal cells, as well as muscular and extracellular matrix precursor cells with a coelomic-epithelium cover. The female gubernaculum persists as the round ligament and penetrates the abdominal wall along with the canal of Nuck (*i.e.*, processus vaginalis peritonei) resulting in being fixed distally in the pubic region.

The round ligament itself is presented as a bilateral structure arising from the intersecting point of the uterus and the uterine tube, the uterine horns. The ligaments course laterally from the uterus through the broad ligament crossing internally within the anterior lamina and ahead the external iliac vessels, running along the pelvic side wall and leaving the abdomen through the internal ring. The round ligament crosses along the inguinal canal with the round ligament artery, external iliac vein, and ilioinguinal nerve and terminates in the labia majorum. It measures to be 10–12 cm on average in length and maintain the retroversion of the uterus [10].

The round ligament primarily consists of muscular tissue developed from the uterus, fibrous and areolar tissue, blood vessels, and nerves. These contents are enclosed by a double fold of peritoneum, in the form of a tubular process, called the canal of Nuck, into the inguinal canal. The canal of Nuck can be anatomically described as a small invaginations of the parietal peritoneum, which is attached to the uterus by the round ligament through the deep inguinal ring into the inguinal canal [11]. The canal of Nuck is normally considered as the counterpart of the processus vaginalis located in males. As an individual matures into an adult, the canal of Nuck disintegrates but some remains may pertain within the body. Incomplete obliteration of the canal of Nuck can give rise to an inguinal mass in females.

2.4. Anatomy of the female groin

The anterior superior iliac spine and pubic crest superiorly enclose the inguinofemoral region, which encompasses the upper thigh region and the caudal portion of the anterior abdominal wall. The abdominal wall and female groin area consist of multiple layers including peritoneum, extraperitoneal fat, various muscle groups, subcutaneous fat, superficial fascia, and skin. The external and internal oblique, transversus abdominis, and rectus abdominis are the muscles of the abdominal wall with the external oblique being the most superficial of all three anterolateral muscles. The fibers of the external oblique result in a thin and strong aponeurosis, which in the groin region manifests itself as a free border known as Poupart's ligament. The iliopsoas muscle and its bursa is laterally caudal to the inguinal ligament. The medial portion of Poupart's ligament is superior to the femoral vessels and the pectineus muscle. The great saphenous vein empties into the femoral vein by passing through the fascia lata [12].

The internal oblique muscle is centered between the external

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