

**Describe the anatomy of the inguinal canal. How may direct and indirect hernias be differentiated anatomically. How may they present clinically?**

Essentially, the function of the inguinal canal is for the passage of the spermatic cord from the scrotum to the abdominal cavity. It would be unreasonable to have a single opening through the abdominal wall, as contents of the abdomen would prolapse through it each time the intraabdominal pressure was raised. To prevent this, the route for passage must be sufficiently tight. This is achieved by passing through the inguinal canal, whose features allow the passage without prolapse under normal conditions.

The inguinal canal is approximately 4 cm long and is directed obliquely inferomedially through the inferior part of the anterolateral abdominal wall. The canal lies parallel and 2-4 cm superior to the medial half of the inguinal ligament. This ligament extends from the anterior superior iliac spine to the pubic tubercle. It is the lower free edge of the external oblique aponeurosis. The main occupant of the inguinal canal is the spermatic cord in males and the round ligament of the uterus in females. They are functionally and developmentally distinct structures that happen to occur in the same location. The canal also transmits the blood and lymphatic vessels and the ilioinguinal nerve (L1 collateral) from the lumbar plexus forming within psoas major muscle.

The inguinal canal has openings at either end – the deep and superficial inguinal rings. The deep (internal) inguinal ring is the entrance to the inguinal canal. It is the site of an outpouching of the transversalis fascia. This is approximately 1.25 cm superior to the middle of the inguinal ligament and lateral to the inferior epigastric artery (from the external iliac artery). The deep inguinal ring is the beginning of an evagination in the transversalis fascia, forming an opening like the entrance to a cave, through which the vas deferens (or round ligament of the uterus in the female), and gonadal vessels pass to enter the inguinal canal. The transversalis fascia continues into the canal, forming the innermost covering (internal fascia) of the structures traversing the inguinal canal.

The superficial, or external inguinal ring is the exit from the inguinal canal. It is a slitlike opening between the diagonal fibres of the aponeurosis of the external oblique muscle, superolateral to the pubic tubercle, through which the spermatic cord or the round ligament of the uterus, emerge from the inguinal canal. The medial and lateral margins of the superficial ring formed by the split in the aponeurosis are called crura. The lateral crus is attached to the pubic tubercle and the medial crus is attached to the pubic crest. Fibres arising from the inguinal ligament lateral to the superficial ring arch superolaterally to the superficial ring. These are known as intercrural fibres and help to prevent the crura from spreading apart – ie preventing the split in the aponeurosis from expanding – increasing the likelihood of prolapse.

So the canal passes obliquely through the three anterior abdominal muscles. Each of the two described openings is protected by two of the anterior muscles. The superficial ring is in the external oblique aponeurosis and is protected posteriorly by the conjoint tendon which is the amalgamation of the internal oblique and transversus abdominis. The deep ring is posterior to the aponeurotic fibres of external oblique and the muscular fibres of internal oblique.

The final anatomical relations to describe of the inguinal canal is that of its anterior and posterior wall, and finally its floor and roof.

The anterior wall of the canal is formed mainly by the aponeurosis of the external oblique with the lateral part of the wall being reinforced by fibres of the internal oblique. The posterior wall is formed mainly by transversalis fascia with the medial part of the wall being reinforced by formation of the conjoint tendon also known as the inguinal falx, which is the merging of the pubic attachments of the internal oblique and transverse abdominal aponeurosis into a common tendon. The iliopubic tract is the thickened inferior margin of the transversalis fascia that appears as a fibrous band running parallel and posterior to the inguinal ligament. The iliopubic tract contributes to the posterior wall of the inguinal canal as it bridges the external iliofemoral vessels from the iliopectineal arch to the superior pubic ramus. The roof of the inguinal canal is formed by the arching fibres of the internal oblique and transverse abdominal muscles. The floor is formed by the superior surface of the in-curving inguinal ligament, which forms a shallow trough. It is reinforced in its most medial part by the lacunar ligament, a reflected part or extension from the deep aspect of the inguinal ligament to the pectineal line of the superior pubic ramus.

The deep and superficial inguinal rings in the adult do not overlap because of the oblique path of the inguinal canal. Consequently increases in intraabdominal pressure act on the inguinal canal, forcing the posterior wall of the canal against the anterior wall and strengthening this wall, thereby decreasing the likelihood of herniation until the pressures overcome the resistant effect of this mechanism. Furthermore, contraction of the external oblique approximates the anterior wall of the canal to the posterior wall. Contraction of the internal oblique and transverse abdominal muscles make the roof of the canal descend, constricting the canal.

In the male it is the spermatic cord which is transmitted by the inguinal canal. It suspends the testis in the scrotum and contains the structures running to and from the testis. It begins at the deep inguinal ring lateral to the inferior epigastric artery, passes through the inguinal canal, exits the superficial inguinal ring and ends in the scrotum at the posterior border of the testis. The spermatic cord has three distinct layers of fascia surrounding it. There is the internal spermatic fascia derived from the transversalis fascia, the cremasteric fascia derived from the fascia of both the superficial and deep surfaces of the internal oblique muscle, and the external spermatic fascia derived from the external oblique aponeurosis. The inguinal canal transmits all of the contents of the spermatic cord, which includes the vas deferens – a 45 cm long muscular tube responsible for conveying sperm from the epididymis to the ejaculatory duct, the testicular artery arising from the aorta and supplying the testis and epididymis, the sympathetic nerve fibres on arteries and both autonomic fibres on the vas deferens, the genital branch of the genitofemoral nerve (L1,2) from the lumbar plexus, supplying the cremaster muscle and the lymphatic vessels draining the testis, passing to the lumbar lymph nodes.

### **Inguinal Hernias**

A hernia is a protrusion of tissue (usually parietal peritoneum and viscera such as fat, gut or omentum) through or alongside an opening in the abdomen that is designed to allow a normal structure to enter or exit. For example the deep inguinal ring may

allow a hernia to appear alongside the spermatic cord, or the femoral canal a hernia alongside the lymphatics. Less often hernias are seen at the umbilicus or alongside the oesophagus and, much rarer, in the obturator foramen and alongside the edge of the rectus sheath. In most patients there is no immediate obvious cause for the hernia but there may be a history of straining the groin such as changing a car tyre. However, there are three likely underlying factors that probably contribute to many hernias. Incomplete adaptation to the upright posture in humans, damage to the ilioinguinal nerve at appendicectomy or other operation, or the persistence or reopening of the processus vaginalis that is seen in infants. Most hernias are reducible, meaning that they can be returned to their normal place in the peritoneal cavity by appropriate manipulation.

Approximately 90% of abdominal hernias are in the inguinal region. The two main types are indirect inguinal hernias (~75%) and direct inguinal hernias (~25%).

### **Indirect inguinal hernia**

This is the most common of all abdominal hernias. It leaves the abdominal cavity lateral to the inferior epigastric vessels and enters the deep inguinal ring. The hernial sac is formed by a persistent processus vaginalis and is surrounded by all three fascial coverings of the spermatic cord. The hernia traverses the entire inguinal canal. It exits through the superficial inguinal ring and commonly enters the scrotum.

Normally, most of the processus vaginalis disappears before birth, except for the distal part which forms the tunica vaginalis of the testis. The peritoneal part of the sac of an indirect hernia is formed by the persisting processus vaginalis. If the entire stalk of the processus vaginalis persists, the hernia extends into the scrotum superior to the testis forming a complete indirect inguinal hernia.

Indirect inguinal hernias can occur in women, but they are twenty more times likely in males. If the processus vaginalis persists in women, it forms a small peritoneal pouch known as the canal of Nuck, that may enter the labium majus. Part of the small intestine may herniate into this pouch and through the inguinal canal, forming an indirect inguinal hernia and a bulge in the labium majus. It is also common in children, and is a result of the reopening of the processus vaginalis. Hence it is also known as congenital inguinal hernia.

The palpation for an indirect inguinal hernia is performed by palpating for the inguinal rings. The superficial inguinal ring is palpable superolateral to the pubic tubercle by invaginating the skin of the upper scrotum with the index finger. The examiner's finger follows the spermatic cord superolaterally to the superficial inguinal ring. Should a hernia be present, a sudden impulse is felt against either the tip or the pad of the examining finger when the patient is asked to cough. More specifically for indirect hernias is palpation of the deep inguinal ring. With the palmar surface of the finger against the anterior abdominal wall, the deep inguinal ring may be felt as a skin depression superior to the inguinal ligament, 2-4 cm superolateral to the pubic tubercle.

### **Direct inguinal hernias**

This form of hernia is also known as acquired inguinal hernia. It is common in elderly men. The sac leaves the abdominal cavity medial to the inferior epigastric artery. It protrudes through an area of relative weakness in the posterior wall of the inguinal canal. The hernial sac is formed by transversalis fascia. It lies outside the processus vaginalis, which is usually obliterated, parallel to the spermatic cord and outside the inner one or two fascial coverings of the cord. It does not traverse the entire inguinal canal therefore – usually only its medial lower end adjacent to the superficial inguinal ring. The hernia protrudes through the inguinal triangle of Hesselbach that lies between the inferior epigastric artery superolaterally, the rectus abdominis medially and the inguinal ligament inferiorly. It emerges through or around the conjoint tendon to reach the superficial inguinal ring, gaining an outer covering of external spermatic fascia inside or parallel to that on the cord. It almost never enters the scrotum.

Palpation of a direct inguinal hernia is performed by placing the palmar surface of the index finger over the inguinal triangle and asking the patient to cough. If a hernia is present a forceful impulse is felt against the pad of the finger. The finger can also be placed in the superficial inguinal ring. If a direct hernia is present, a sudden impulse is felt at the side of the finger when the person coughs.

### **Clinical presentation of inguinal hernias**

Hernias produce different symptoms or feelings. Sometimes a protrusion in the groin area between the pubis and the top of the leg may be visible, including the enlargement of the scrotum in males, or the feeling of pain when straining during urination or a bowel movement or lifting a heavy object. The pain can be sharp and immediate. Other times patients just feel a dull aching sensation, a vague feeling of fullness, nausea or constipation; these feelings typically get worse toward the end of the day or after standing for long periods of time and may disappear when the patient lies down. And, while people certainly can live for years with hernias, without treatment they will not disappear.

If the hernia can be pushed back into the abdominal cavity, it is referred to as a reducible hernia, which while not an immediate health threat, will require surgery to disappear. If it cannot be pushed back, it is non reducible. This is a condition that may lead to dangerous complications such as the obstruction of the flow of the intestinal contents or intestinal blood supply (strangulation), leading to tissue death. Intestinal obstruction produces nausea, vomiting, loss of appetite, and abdominal pain and usually requires immediate surgery. A strangulated hernia is very painful and requires immediate surgery.