The use of meshes in male groin hernia repairs

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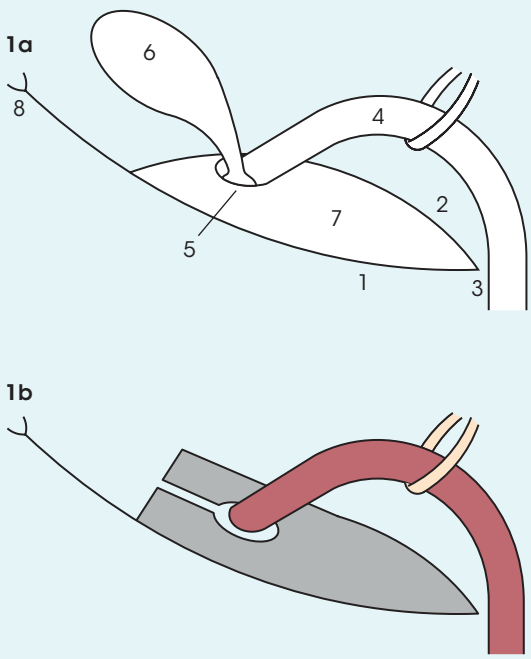
The use of a mesh is standard practice in the surgical repair of groin hernias. No one type of mesh or surgical technique appears to be superior to another. Here the authors discuss the evolution of groin hernia repair, the different types of mesh, as well as the investigation and management of complications that can occur, albeit in a minority of patients.

The earliest recorded historical descriptions of hernia date back to 1500 BC.[1] Surgical repairs of inguinal hernia have been mentioned in the literature from the first century AD.[2] Improved understanding of the anatomy of the groin and inguinal canal in the 16th century led to better operations performed on an anatomical basis with consequently better outcomes. However, despite some improvement, the results were far from satisfactory, with a >30% relapse rate even in the mid-19th century.

The development of effective anaesthesia, understanding of the importance of asepsis, and further improvement in the understanding of surgical principles during the second half of the 19th century revolutionised hernia surgery. Over the years, five rules of inguinal hernia surgery had become apparent: asepsis; high ligation of the hernia sac; narrowing of the internal inguinal ring; reconstruction of the posterior wall of the inguinal canal, and tensionless repair.



1. Inguinal ligament
2. Conjoint tendon
3. Pubic tubercle
4. Spermatic cord structures retracted with a sling
5. Deep inguinal ring
6. Sac of an indirect hernia (this sac would be emptied and then excised)
7. Transversalis fascia covering the posterior wall of the inguinal canal. A direct hernia would bulge through this. It is this part of the posterior wall that is reinforced by placement of a mesh
8. Anterior superior iliac spine

Figure 1a. A schematic diagram of the right inguinal canal after the external oblique muscle (that forms the anterior wall of the inguinal canal) has been opened
Figure 1b. Shows a mesh placed over the posterior wall of the inguinal canal. Superiorly, it is sutured to the conjoint tendon, and inferiorly to the inguinal ligament. Both sets of sutures run medial to lateral, from the pubic tubercle to at least where the deep ring is located. Laterally, the mesh has been split around the spermatic cord structures

Today, inguinal hernias remain the commonest type of abdominal wall hernia and account for approximately 75% of all cases. Nearly 100 000 hernia operations are performed annually in England[3] while approximately 750 000 inguinal hernia repairs are undertaken annually in the USA. About one in four men will develop a hernia in their lifetime, while the lifetime risk in women is 3–5%.[4]

In 1888, Eduardo Bassini was the first surgeon to develop a technique of inguinal hernia repair that was safe and did not suffer from the high rate of recurrence that previous techniques did. Subsequently, Earl Shouldice modified his technique and popularised the Shouldice method by setting up his hospital in 1945. The Shouldice Hernia Hospital,

where predominantly non-mesh repairs are undertaken, has a <1% lifetime recurrence rate with a complication rate of <0.5%.

The excellent results with some of the non-mesh repairs at specialist centres have not been replicated uniformly in other parts of the world. This led to the development of synthetic materials (in the 1940s) for reinforcement of the posterior wall of the inguinal canal, and these techniques have now been safely employed widely for over 30 years. Dr Irving Lichtenstein was one of the first to publish (in 1987) his technique with polypropylene mesh in over 6000 patients with a recurrence rate of 0.7%. His 'tensionless' mesh hernia repair technique is now one of the most important pillars of hernia surgery (see Figure 1). It was thought that a natural tissue repair (without mesh) places tissues under tension and predisposes to a higher risk of recurrence. However, this remains a controversial subject even today. Also, during this time, laparoscopic techniques with (1989) and without mesh (1979) were also developed.

Proponents of non-mesh hernia repairs cite the use of natural tissue to repair the hernia and the avoidance of synthetic foreign material (with the complications that come along with it) as the main benefit. However, studies comparing the two techniques have failed to prove superiority of one technique over the other.[5] The Lichtenstein tension-free hernioplasty technique, using a lightweight polypropylene (Prolene) mesh, is by far the commonest technique employed by surgeons worldwide. Non-mesh techniques continue to be employed only in centres where there is extensive experience with this technique or in parts of the world where these synthetic materials are not available and surgical cost is a major concern. Table 1 summarises the names of some of these techniques.

Mesh	Non-mesh
Lichtenstein technique	Bassini repair
Patch and plug repairs	Shouldice repair
Prolene hernia system (PHS)	Desarda technique
Laparoscopic TEP repair	McVay repair
Laparoscopic TAPP repair	Marcy repair
Stoppa technique	

Abbreviations: TEP: totally extraperitoneal; TAPP: transabdominal preperitoneal

Table 1. Commonly performed mesh and non-mesh inguinal hernia repair techniques.

The use of meshes in surgery has been under intense scrutiny over the past decade. The alleged indiscriminate use of meshes in women with pelvic organ prolapse and incontinence was at the centre of controversy in 2016, and initially led to suspension of mesh use in pelvic floor surgery in women. This was followed by the emergence of new guidelines in how and when surgery (with or without mesh) should be offered.[6] As a consequence of these events, there were concerns raised about the use of mesh in hernia surgery in the UK in an investigation conducted by the BBC's Victoria Derbyshire programme in 2018. As these are very commonly performed operations, the investigation claimed up to 170 000 patients may have suffered complications over a six-year period.[7] Many of these complications occurred in patients where mesh implants that have subsequently been withdrawn from the market were used. The issue here is probably how these products made it through without being adequately tested prior to being used in patients.

The UK MHRA (Medicines and Healthcare products Regulatory Agency) and RCS England (Royal College of Surgeons of England) have maintained that there is no evidence at present to alter their position on the use of mesh in hernia surgery,[7,8] as long as it is used in line with NICE guidance.[9] This is backed by recent studies where the use of mesh in surgical repair of hernia has not been associated with increased complications, and has even been shown to be superior to hernia repairs that do not involve mesh.[10] However, they do recognise that a minority of patients experience complications and that there should be a nationwide registry to track mesh usage and complications to identify best practice.

The international guidelines for groin hernia management published by the HerniaSurge Group strongly recommend using mesh for repair of groin hernias.[11] If a non-mesh repair is used, they recommend the Shouldice technique. The most important factors appear to be hospital volume and the surgeon's expertise with the repair technique being offered regardless of whether mesh is used or not.

Ultimately, it remains a decision to be made by the patient and the surgeon following a discussion about the risks and benefits of mesh versus non-mesh repairs, or not operating at all. Mesh repair of hernia continues to be the commonest repair performed in the UK (and in the world), accounting for more than 90% of cases. It is imperative that care providers understand the implications of implanting a medical device and possess the skills to deal with potential short- and long-term complications.

Types of meshes used: pros and cons

A hernia mesh is a medical device that provides reinforcement to the weakened abdominal wall by promoting the formation of scar

tissue. Meshes made from different materials are available in a variety of shapes and sizes. They are commonly classified based on their origin (synthetic or animal-derived, *ie* bovine or porcine), pore size (microporous/macroporous), weight (light/heavy), absorbability (absorbable/non-absorbable/mixed), shape (patch/plug/sheet), constitution (monofilament/multifilament/braided/patches), and material used (polypropylene/polyester/ePTFE, collagen/mixed).

Although the search for the ideal mesh in hernia surgery continues, a flat and lightweight mesh with large pores made from a synthetic, monofilament, and non-absorbable material appears to be associated with the lowest incidence of mesh-related problems. Presumably, a lightweight macroporous mesh would cause less discomfort to the patient, monofilament material would be less susceptible to infection, while a non-absorbable mesh will impart permanent reinforcement (unlike a non-absorbable mesh which will degrade and lose strength with time).

Apart from the above-mentioned mesh characteristics, some of the other relevant properties of a mesh include tensile strength, burst strength, strain, reactivity/biocompatibility, elasticity, compliance, isotropy and shrinkage. The ideal mesh does not exist, and each mesh characteristic confers its own advantages and disadvantages.[12] Depending on the clinical scenario and surgeon's experience, the mesh that suits that specific situation must be chosen. Table 2 summarises the common types of mesh available commercially.

Mesh name (Manufacturer)	Material	Pore size	Absorption
Vicryl (Ethicon)	PG	Small	Yes, 60–90 days
Vypro, Vypro II (Ethicon)	PP/PG	Large	Partially, 42 days
Prolene (Ethicon)	PP	Small-large	No
Surgipro (Autosuture)	PP	Small-medium	No
Ultrapro (Ethicon)	PP/PGP	Large	Partially (<140 days)
Parietex (Medtronic)	Polyester/collagen	Large	Partially (20 days)
Proceed (Ethicon)	PP/ cellulose	Large	Partially (<30 days)
Goretex (Gore Medical)	ePTFE	Very small	No
Strattice (LifeCell)	Porcine/bovine acellular dermis	Sheet	
Surgisis (Cook)	Small intestinal submucosa (porcine)	Sheet	
Permacol (Medtronic)	Porcine/bovine acellular dermis	Sheet	
Alloderm (LifeCell)	Human acellular dermis	Sheet	

Key: PP = polypropylene; PG = polyglactin; PGP = polyglecaprone; PTFE = polytetrafluoroethylene

Table 2. Commonly used meshes in hernia surgery[12,13]

Complications from meshes: types and incidence

Like any other operation, hernia surgery is associated with its own unique set of complications. Laparoscopic and open operations have a similar complication rate, although the complication profile is slightly different. As would be expected, urgent/emergency repairs are associated with more complications than elective repairs. Some complications can be evident immediately after surgery while others may arise many months later.

However, many of the symptoms associated with hernia repair may not necessarily be due to the presence of mesh. Many of the persistent symptoms and complications following hernia surgery are seen in mesh as well as non-mesh repairs. Some of the common complications and their incidences are listed in Table 3. Other complications not included in the table are urinary retention (0.4% after local anaesthesia, 2.2% after general anaesthesia), and sexual dysfunction and pain (3.7% and 12.5%, respectively). Complications specific to mesh repairs include adhesion, bowel obstruction, organ perforation, mesh infection (0.1%), mesh shrinkage, mesh migration, mesh rejection, and mesh degradation. However, many of these mesh-specific complications involving the bowel are rarely seen after surgery for groin hernias; they are usually a concern after mesh repair of ventral/incisional abdominal hernias.

Chronic groin pain, defined as bothersome/moderate pain that lasts for more than three months after surgery and impacts daily activities, is often attributed to the use of mesh and has been the focus of much controversy and debate.[15] However, a Cochrane review published in 2018 comparing mesh versus non-mesh techniques of inguinal (as well as femoral) hernia repair did not reveal any differences in the incidence of complications.[16] It appears to be a problem regardless

of whether mesh is used or not, and has an incidence of approximately 10%. A recent study from Germany explored the relation between surgical outcomes and hospital volumes.[17] As has been demonstrated in many other surgical specialties, lower hospital volumes (fewer than 75 per year) of hernia surgery were associated with more complications. In their analysis, which looked at over 133 000 patients, approximately 3% required treatment for chronic pain.

How these complications manifest and how to investigate them

Hernia mesh complications are often difficult to diagnose and may present with vague symptoms. However, the surgical history of a hernia repair with mesh is generally sufficient to identify the culprit. Chronic groin pain is by far the commonest complication and usually manifests as a sharp pain in the affected groin. Sometimes the pain may radiate along a specific groin nerve distribution. The groin pain may be associated with a burning sensation and the feeling of the presence of a foreign body. The patient may also experience pain in the testis, pain while walking, and pain during sexual intercourse. Often, the patient has generalised malaise. To differentiate from other causes of pain (*ie* infection, recurrence, pubic bone osteitis, mesh migration) imaging in the form of ultrasound, CT or MRI is usually required.

Even though mesh infection is relatively rare, it is a dreaded complication. Patients with a previous hernia repair presenting with fever, chills, and malaise should raise suspicion of an infected mesh. Findings on examination would include local tenderness, swelling, erythema, warmth, and purulent discharge (not always) from the wound. Although usually clinically evident, ultrasound or CT scan aid diagnosis by demonstrating collections, oedema/stranding of fat around the mesh, and other signs of tissue infection or ischaemia.

Other complications such as seroma and haematoma present as an uncomfortable swelling in the groin or the scrotum. If the collection is infected, the patient will have signs of infection with high fever, a raised WCC and CRP on blood tests, more than expected postoperative pain, erythema and tenderness over the surgical wound, and occasionally purulent discharge from the wound. Postoperative complications are often easily diagnosed clinically and can be supported with the help of an ultrasound scan.

More serious complications due to the bowel coming into contact with mesh can give rise to adhesions and symptoms of bowel obstruction. Although this is more commonly a concern following repairs for incisional hernias, it may occasionally occur following transperitoneal laparoscopic placement of hernia mesh. Adhesions may result in partial obstruction that resolves spontaneously. Failure of conservative treatment in this setting will need the patient to undergo surgery to relieve the obstruction and remove the mesh. Rarely, bowel perforation may occur leading to sepsis. This too will necessitate surgery with resection of the affected segment of bowel and excision of the mesh. Diagnosing these serious complications usually requires X-rays and cross-sectional imaging in the form of a CT scan in the acute hospital setting.

Risks	% in the average patient	Comments
Wound infection	0.1–0.2%	Increased risk with smoking
Pneumonia	0.1%	Movement, deep breathing, and stopping smoking can help prevent infections
Urinary tract infection	0.1%	Drinking plenty of fluids and, if applicable, appropriate catheter care
Venous thrombosis	0.1%	Getting up, walking 5–6 times/day reduces the risk
Chronic pain	10–12% (possibly less with laparoscopic)	Some risk factors include emergency surgery, scrotal hernia, repair of recurrence
Recurrence	1–17% (wide variation based on duration of follow-up)	Lesser with mesh repair. Higher rate in older men with laparoscopic repair
Neuralgia	Open 10.7% Laparoscopic 7.4%	Due to pressure, staples, stitches, or a trapped nerve
Seroma	Mesh repair 8% Non-mesh repair 3.1%	May require aspiration
Haematoma	Mesh repair 2.2%Non-mesh repair 7%	Usually treated with anti-inflammatories, elevation, and rest

Table 3. Risks in the average patient undergoing open and laparoscopic inguinal hernia surgery (based on the American College of Surgeons risk calculator).[24] It is difficult to determine the extent of overlap between the chronic pain and neuralgia groups

Mesh rejection is rare but sometimes the materials in the mesh may trigger the body's immune system leading to rejection. This manifests as extreme surgical site swelling, erythema, tenderness, and flu-like symptoms. Mesh migration is more common following laparoscopic repair techniques and occurs due to detachment of the mesh. This may either be asymptomatic or may result in recurrence, pain, or more severe damage in the form of mesh erosion (into urinary bladder, vas deferens, or bowel causing recurrent urinary infections/haematuria, vasal obstruction, or a bowel fistula respectively).

How to treat complications

Mesh infection

These are quite difficult to treat and monotherapy with antibiotics is usually related to a poor outcome. This is predominantly because of the thick fibrous capsule that develops around the mesh that prevents antibiotic penetration. Also, *Staphylococcus spp.* (*S. aureus* and coagulase-negative staphylococci) are the most common causative organism in mesh infections and these bacteria produce a biofilm that reduces antibiotic efficacy.

A combination of broad-spectrum parenteral antibiotics and percutaneous drainage of infected collections under radiological guidance is usually needed to treat mesh infections.[18] Subsequently, antibiotic therapy should be tailored based on the results of blood or pus culture and sensitivities. This approach is successful in approximately 60% of patients. Irrigation with antibiotics (usually Gentamicin) through percutaneous drains has been reported,[19,20] but there is a lack of evidence to support this as a routine practice.

Cases refractory to medical treatment and patients who present with profound sepsis will unfortunately require surgical removal of the mesh and surgical debridement of any infected or necrotic tissue.[21] Antibiotics should be continued for at least two weeks after mesh removal. Persistent sepsis should raise suspicion of incomplete mesh removal and may necessitate repeat debridement.

Chronic groin pain

Once other causes have been ruled out and a diagnosis of chronic groin pain has been made, a multidisciplinary approach is needed in such patients.[22] These patients are already usually on a substantial dose of analgesics; however, sometimes the pain may be refractory to oral medications and requires intervention in the form of diagnostic and therapeutic nerve blocks. Nerve blocks help to control the pain and also confirm the diagnosis. Typically, a long-acting anaesthetic (for example, bupivacaine) mixed with a glucocorticoid (for example, hydrocortisone) is injected. Sometimes, this may break the pain cycle and provide permanent cure.

Response to a nerve block implies the pain is neuropathic in origin and, if the effect is transient but reproducible, the affected nerve can be sacrificed to achieve permanent relief. This can be done via percutaneous ablation with a neurolytic solution (for example, phenol, alcohol) or via surgical groin exploration, mesh removal, and neurectomy (more effective than ablation).[23] Triple neurectomy is preferred over selective neurectomy and has been shown to be effective in over 90% of patients. Mesh removals are difficult operations and how much of the mesh can be safely removed depends on the time elapsed since the initial surgery, the extent of inflammatory reaction, and the degree of erosion into surrounding structures.

Patients who do not respond to a nerve block are usually best served by ongoing medical management. In addition to opioids, medications such as pregabalin and/or duloxetine may need to be added. Some surgeons may offer surgery for this group too. These patients, as well as patients whose pain recurs after mesh removal and/or triple neurectomy, may benefit from laparoscopic implantation of nerve stimulators. However, this has not been widely studied and the evidence to support this as a routine practice is currently lacking.

Other complications

Potentially life-threatening complications of hernia mesh that involve mesh adhering to or perforating into bowel need urgent surgical intervention. This is most often an urgent operation in the form of a laparotomy with adhesiolysis, excision of the involved segment of bowel, and mesh removal. Sometimes, the mesh can only be removed partially as it is not always possible to remove it in its entirety.

Summary

- The use of a mesh is standard practice in the surgical repair of groin hernias.
- There is no evidence to suggest that one particular type of repair is superior compared with others (*ie* open versus laparoscopic, non-mesh versus mesh). In many instances it may not be possible to achieve a tension-free repair without a mesh.
- There are several types of mesh available, and there is no evidence that one particular mesh is superior. The current trend is towards using a lightweight mesh made from a synthetic, monofilament, and at least partly non-absorbable material.
- The incidence of mesh-related complications is low.
- If a patient presents with chronic pain, there may be several possible causes, unrelated to the mesh. Management involves a careful history, cross-sectional imaging, a multidisciplinary approach and a stepwise escalation of therapy.

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