Inguinal Herniorrhaphy: Complications and Recurrences

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Because laparoscopic surgical techniques have been applied to inguinal hernia repair, the surgeon has been forced to re-evaluate his particular open technique and its resultant complications and recurrences to determine what is the best procedure for patients. In this article, complication rates for open inguinal herniorrhaphy varied from 7% to 12% with some reports as low as 1% using the anterior mesh technique. The most frequent complications were wound problems and scrotal and testicular swelling. In the laparoscopic series using retroperitoneal mesh or the "onlay" technique, the number of complications in 3,288 inguinal herniorrhaphies was 522 (16.8%). On the other hand, recurrence rates for open inguinal herniorrhaphy ranged from 1% to 10% for primary repair to as high as 35% for the repair of recurrent hernias. The laparoscopic series involved 3,178 repairs using the retroperitoneal and onlay techniques, and 61 recurrences (1.92%) were noted in a follow-up greater than 6 months. These data emphasize that complication and recurrence rates are similar between open and laparoscopic inguinal herniorrhaphy.

Key words: Complications, laparoscopic inguinal herniorrhaphy, recurrences.

Each year, approximately 700,000 inguinal herniorrhaphies are performed as outpatient or inpatient procedures, and the morbidity, mortality, and recurrence rates have been reportedly low from some centers, although, worldwide morbidity ranges from 1% to 26% (average 6%),[1] mortality 0.3%, and an average recurrence rate of 10%. The application of laparoscopic techniques to inguinal hernia repair in the past 4 years has caused surgeons to re-evaluate their operative technique and results and compare them with complications and recurrences in the open operation. The advocates of laparoscopic surgery have emphasized that postoperative pain is decreased, and that there is an earlier return to normal daily activity when compared with open inguinal hernia repairs. These issues are important when one considers the total cost of medical care; however, these problems must be addressed in a prospective randomized trial. Complication and recurrence rates are the primary concerns of the patient, although the employer is equally concerned because of the insurance premium and the loss of employee work activity from the employee's inability to return to work. Because complications and recurrences are the major issues, a critical review is necessary comparing open and laparoscopic inguinal hernia repair.

Complications of Open Inguinal Herniorrhaphy

Complications of inguinal herniorrhaphy include intraoperative and postoperative problems. Intraoperative complications include vascular injury that can produce hemorrhage or postoperative hematoma secondary to laceration of the inferior epigastric vessels, external iliac vessels, vessels of the spermatic cord, or femoral artery and vein. These injuries are usually recognized and repaired immediately. Nerve injury can occur intraoperatively but often is not recognized until the postoperative period. Included in this problem are injuries to the iliohypogastric, ilioinguinal, genitofemoral nerves, and lateral femoral cutaneous nerve. Other injuries include disruption to the ductus deferens, spermatic cord, and the small or large intestine. Failure to recognize another unilateral or contralateral hernia has been recorded, and it is often necessary to make a separate incision for diagnosis on the contralateral side. The potential femoral hernia region often is not evaluated well at the initial procedure, and Cooper's ligament, preperitoneal, and laparoscopic inguinal herniorrhaphies are the only procedures that adequately correct this defect. One advantage of the laparoscopic repair is that the surgeon can easily visualize both inguinal regions, and one or both can be corrected in one operation. This issue is particularly important in pediatric patients where the incidence of bilaterality is 30% to 40% as opposed to 10% to 12% in adults. However, the open operation in the pediatric age group has been associated with low infection rates (1% to 2%),[2] low incidence of ilioinguinal nerve and vas deferens injuries, intraoperative bleeding, and

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recurrence rates of less than 1%.[3] Therefore, the application of laparoscopy to this age group does not seem to be warranted except with the possible insertion of the laparoscope through the hernia sac to visualize the opposite side.

In adult patients, complication rates from open inguinal herniorrhaphy vary from 1% to 26% with most reports ranging from 7% to 12%. Ponka[4] reviewed several other series of inguinal hernia repairs. The complications of inguinal hernia repair ranged up to 24%, and the findings are listed in Table 1.[5] It should be noted that postoperative hematoma, wound infection, and testicular and/or scrotal swelling occurred at a high percentage (5%). This review of multiple types of open surgery until 1976 has been associated with a significant number of complications, and newer procedures have been developed to try to reduce the high complication rate.

In a later series, postoperative complications were reported in 548 adult patients who had indirect inguinal hernia repairs.[6] A total of 126 complications were recorded for a complication rate of 26% (Table 2). Wound complications occurred in 9%; of those, hematoma and seroma were most frequently observed. It was noted that 3% of all complications were infectious, and scrotal and testicular problems developed in an additional 6% of patients, 0.55% of whom had testicular atrophy. Although there were no

Table 1. Incidence of Postoperative Complications Reported in the Literature

	Davis (1916)	*Beekman and Sullivan (1939)*	*Glenn (1947)*	*Levy et al* (1951)*	*Ljungdahl (1973)*	*MacLaughlin et al 1976†*
Wound						
Ecchymosis	Not listed	Not listed	Not listed			
Hematoma	7.5%	0.8%	0.17	2.1	0	1
Infection	4.0%	4.9%	1.1%	1.7%		4
Seroma					0.24	
Scrotal-Testicular						
Hematoma	7.5%	0.7%				
Swelling			0.32	*	0.47	5.0
Atrophy					0.47	
Sterility	(Incidence not reported)					
Bilateral atrophy	(Incidence not reported)					
Orchidectomy	0.33%					
Hydrocele					2.59	
Genitourinary						
Retention			0.71	0.3	1.42	2
Infection		0.1%	0.13			6
Obstruction					0.47	
Infection						
Pulmonary						
Atelectasis	9.2%	8.5%	0.76	2.4		
Pneumonitis	0.5%		0.39		0.24	
Tracheobronchitis	6.6%					
Pulmonary embolus	0.13		0.26	0.2	0.24	
Extremities						
Phlebothrombosis	0.13	0.3%	0.32	0.2	0.47	
Gastrointestinal						
Ileus		0.3%		0.5	0.24	1.0
Acute gastric dilatation		0.05%				
Cardiac complications						2
Neuropathy					0.47	
Headache		0.2%				
Dermatitis		0.1%				
Postoperative psychosis		0.05%				
Recurrences	4.0%				4.0	
Deaths	0.53%		0.34			3*

*Levy et al: "Swelling of the scrotum and spermatic cord was the most frequent postoperative complication."
†MacLaughlin, et al., operated upon elderly patients with complications.
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Table 2. Postoperative Complications in 548 Adult Patients With Indirect Inguinal Hernias

	No.
Wound complications	
Early	52
Seroma	22
Hematoma	9
Minor wound infection	8
Wound abscess	6
Swelling and induration	2
Stitch abscess	1
Minor wound separation	4
Late	4
Numbness	3
Keloid	1
Skin reactions	6
Sensitivity to tape	5
Reaction to antiseptic	1
Testicular	34
Scrotal edema, swelling, induration, and ecchymosis	20
High riding testicle	8
Impotency	3
Atrophic testicle	2
Bilaterally atrophic testes	1
Urinary tract	11
Urinary retention	9
Cystitis	2
Pulmonary	11
Bronchitis-pneumonitis	3
Atelectasis	3
Upper respiratory tract infection	2
Pulmonary infarcts (questionable)	3
Thrombophlebitis	1
Complications attributable to spinal anesthesia	3
Headache	1
Backache	2
Cardiovascular	4
Vasovagal reaction	1
Congestive heart failure	1
Supraventricular tachycardia	1
Anginal attack	1
Total	126

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deaths in this series, 7.5% of the patients subsequently died within 13 years of the operation because of acquired or concomitant illnesses.[6]

Cooper's Liagment Repair

The largest series of patients who had a Cooper's ligament repair was reported by Rutledge on 1,142 operations in 942 patients.[8] This series spanned 25 years of one surgeon's practice and included a standard Cooper's ligament repair in which the relaxing incision defect was covered with Marlex (Bard Vascular, Billerica, MA) mesh in 13.4% of the primary and 29.6% of recurrent repairs. Overall, a 2% recurrence rate was recorded with an average follow-up of 9 years, and other complications included testicular atrophy that developed in 4.6% of primary repairs and in 7.9% of recurrent hernia operations with an overall incidence of 5%. One patient had temporary swelling in a leg, 2 patients had pulmonary emboli, and 1 patient had superficial thrombophlebitis. In addition, 1 patient developed a fecal fistula, and 5 patients had a draining sinus related to the mesh, which eventually closed. Ten patients had significant incisional pain, and numerous patients had postoperative inguinal numbness related to the fact that the ilioinguinal nerve frequently was divided during the operation. This report emphasizes that the Cooper's ligament repair is a very good repair and stresses that a low complication rate can be achieved when hernias are repaired in large numbers by one surgeon. However, the total number of these complications may be difficult to interpret because many of the problems were recorded through a postoperative telephone survey.

In another large series of adult patients, multiple inguinal hernia repairs (n = 961) were reported by Rydell.[1] The incidence of complications is reported in Table 3. The overall local complication rate was 8.7%

Table 3. Complications in Adults After Inguinal Hernia Repair

Complications	*No.*	*%*
Local (1,053 hernias)		
Wound	21	2.0
Major infection	14	1.3
Hematoma	7	0.7
Scrotal and cord (924 male hernias)	62	6.7
Marked swelling	24	2.6
Testicular atrophy	16	1.8
Postoperative hydrocele	5	0.5
Ilioinguinal neuritis	14	1.5
Cut vas deferens	3	0.3
Total	83	8.7
Systemic (961 operations)		
Cardiovascular-pulmonary	39	4.1
Atelectasis and pneumonitis	24	2.5
Thrombophlebitis	13	1.4
Coronary occlusion	2	0.2
Urinary retention (requiring TUR)	10	1.0
Urinary infection	5	0.5
Miscellaneous	12	1.3
Total	66	6.9

Abbreviation: TUR, Transurethral resection. Reproduced with permission.[1] Copyright 1963, American Medical Association.

and included wound infection (1.3%) and hematoma formation (0.7%). An additional 6.7% had scrotal and cord complications including significant swelling in 2.6%, and another 1.5% had ilioinguinal neuritis. In 6.9% of patients in this series, systemic complications developed, 4.1% of which were cardiovascular/pulmonary, 1% of which involved urinary retention, 0.5% of which involved urinary infection, and 1.3% of which were miscellaneous problems. Therefore, the combined local and systemic complication rate was 15.6%. General and spinal anesthesia were used, and cardiopulmonary problems should decrease when local anesthesia and sedation are used primarily. Wound infection should also decrease when perioperative antibiotics are given.

Shouldice Repair

Wantz[9] reported a series of 4,114 Shouldice hernioplasties and recorded a wound infection rate of 0.58%, hematoma formation 0.43%, pulmonary embolus 0.07%, hemorrhage 0.02%, ischemic orchitis 0.61%, and testicular atrophy in 0.34% (Table 4). Ischemic orchitis developed in those patients from injury to the testicular artery and occurred in 2.1% of patients with recurrent hernias as opposed to 0.3% with primary repair. In addition, these procedures can be performed under local anesthesia, and these complication rates again show the effectiveness of this technique when an high volume is performed by one surgeon.

Preperitoneal Repair

Besides the anterior approach to inguinal herniorrhaphy, the preperitoneal method of hernia repair using an inguinal transverse incision has been popularized by Stoppa et al[10] and Nyhus et al,[11] especially for the management of large and recurrent inguinal hernias. This method has progressed from suture repair of the iliopubic tract to Cooper's ligament to its present method where a large prosthetic mesh is used to reinforce the entire myopectineal orifice.

Table 4. Complications in 4,114 Hernioplasties of the Groin

	No.	*Rate (%)*
Wound infection	24	0.58
Hematoma	18	0.43
Pulmonary embolus	3	0.07
Hemorrhage	1	0.02
Ischemic orchitis	25	0.61
Testicular atrophy	14	0.34

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Stoppa et al[10] have extended the operation to include simultaneous bilateral and recurrent inguinal hernia repairs using a large, buttressing prosthesis. In this series of 572 hernia repairs,[10] 94.7% had an uncomplicated postoperative course. The hematoma rate was 3.2%, sepsis rate 2.1%, chest infection (0.01%), phlebitis (.002%), and pulmonary embolus (0.002%) with an operative mortality of 0.7%.

Similarly, Nyhus et al[11] reported a series of 203 recurrent groin hernias in 195 patients that were repaired using a large retroperitoneal prosthesis to cover the entire inguinal floor. In this series, there was a 2.5% incidence of superficial wound infection, no recurrences, and a 0.5% incidence of hydroceles. In addition, 1.5% of the repairs developed ventral hernias. These data corroborate Stoppa's results and emphasize the importance of reinforcing the entire myopectineal orifice (Fig 1) and the efficacy and low risk of using prosthetic mesh.

Anterior Mesh Technique

Anterior placement of a synthetic prosthesis in the inguinal canal has been advocated by Lichtenstein and Shulman,[13] who reported excellent results with this technique. Similarly, Shulman et al[14] reported a large multi-institutional series that reviewed the complications and results using the anterior mesh repair of the inguinal floor. The results of these 3,019 operations are recorded in Table 5. The overall complication rate included a 0.03% incidence of wound infection, no rejection of the mesh, and only a 0.2% incidence of recurrence. These excellent results emphasize and corroborate the concepts proposed in the preperitoneal technique of reinforcement of the entire inguinal floor, and they show the benefit of a tension-free repair to decrease postoperative pain and prevent tissue ischemia and impaired wound healing.

The incidence of intestinal incarceration in an inguinal hernia is approximately 10% for indirect inguinal hernias and 20% for femoral hernias.[15] The significance of incarceration is that it can progress to intestinal strangulation and, eventually, infarction of the bowel thereby increasing the incidence of infection, hernia recurrence, and operative mortality. The operative mortality among patients undergoing emergency operation can be as high as 13%. This emphasizes that inguinal hernias should be operatively managed on an elective basis.

Injury to the ilioinguinal, iliohypogastric, and genitofemoral nerves has been observed with greater frequency. The iliohypogastric nerve is located 1 to 2 cm above the inguinal canal and provides sensation

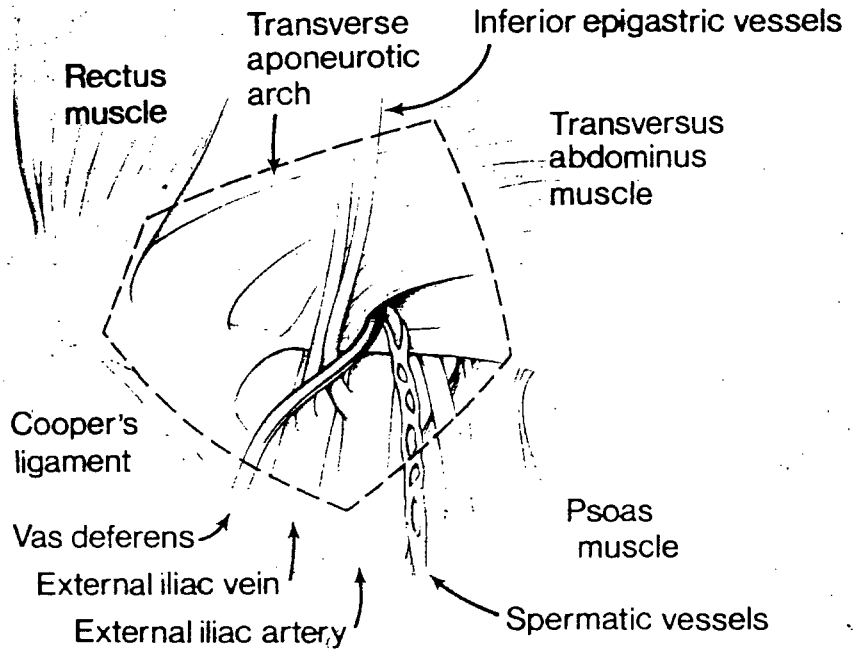

Figure 1. Myopectineal orifice. (Reproduced with permission.[12])

to the suprapubic area. The genitofemoral nerve rises from the sacral plexus lying on the surface of the iliopsoas muscle, and it divides into the genital and femoral branches. The genital branch perforates the internal oblique muscle at the origin of the cremaster muscle and provides both motor innervation to the cremaster muscle and sensory innervation to the skin of the penis and scrotum. The femoral branch is sensory to the skin of the upper lateral thigh and, because this branch lies deeper, it is less likely to be injured. In the laparoscopic technique, the lateral femoral cutaneous nerve can also be injured because it lies on the iliacus muscle. Stapling or suturing a prosthesis around these nerves will result in pain and anesthesia lasting 6 months or longer, and identifying these nerves at the time of surgery is extremely important. These complications emphasize the importance of surgical technique and a thorough knowledge of anatomy to minimize the occurrance of these problems.

Complications of Laparoscopic Inguinal Herniorrhaphy

The application of laparoscopy to repair inguinal hernias has recently reemphasized the necessity of reinforcing the entire myopectineal orifice with a prosthetic mesh in a fashion similar to the preperitoneal approach as advocated by Nyhus[11] and Stoppa.[10,16] In a recent review of laparoscopic complications,[17] four types of laparoscopic inguinal hernia repairs were performed. Complications reporting this data are recorded in Table 6. In the first type, the internal inguinal ring was closed with staples, and the average follow-up in this group was 24 months (1 to 64 months) with the most common postoperative complication being testicular pain (2.2%). This was advocated by Ger,[18] and the overall complication rate was 4.4% (Table 6).[17] The second type of repair included those who were treated with a "plug and patch" technique and had an average follow-up of 8

Table 5. Results of the Patch Repair of Inguinal Hernias Without Formal Closure of Defect

Name	*Study Dates*	*No. of Operations*	*No. of Infections*	*No. of Rejections*	*No. of Recurrences*	*% of Recurrences*
Martin RE	1976-1984	550	0	0	0	0
Barnes JP	1976-1989	271	0	0	0	0
Capozzi JA	1978-1988	745	0	0	4	0.54
Tinckler LF	1980-1985	392	1 (0.25)	0	3	0.77
Lichtenstein IL	1984-1989	1,552	0	0	2	0.13
Totals		3,019	1 (0.03)	0	6	0.2

Note: Summary: 0.03%, rate of infection; rate of rejection, 0; rate of recurrence is 0.2%.
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Table 6. Complications of Laparoscopic Inguinal Hernia Repair

Type of Repair	*Patients/ Hernias*	*Age*	*Follow-up*	*Complications*	*No. (%)*
Closure of internal inguinal ring and hernia sac	87/89	Avg <50 yr	1 to 64 mo avg 24 mo	Recurrences	2 (2.2)
				Testicular pain	2 (2.2)
Plug and patch of internal ring	74/87	Avg <50 yr	up to 15 mo avg 8 mo	Recurrences	6 (6.8)
				Palpable mesh	3 (3.4)
				Bladder injury (recognized & repaired)	1 (1.1)
				Mesh migration into scrotum	1 (1.1)
				Hydrocele of scrotum	1 (1.1)
Laparoscopic transperitoneal suture repair of transversalis fascia to iliopubic tract or Cooper's ligament	28/30	Avg <55 yr	<6 mo	Recurrences	2 (6.6)
				Laparoscopic procedure converted to open procedure	2 (6.6)
				Unable to visualize iliopubic tract	1
				Bladder injury	1
				Hydrocele	
				Treated with aspiration × 3 resolved	1 (3.3)
				Bladder injury	1 (3.3)
Repair of inguinal hernia with a large prosthesis					
Transperitoneal onlay prosthesis	182/186	13 to 78 yr avg 48 yr	3 to 52 wk avg <5 mo	Recurrences (2 retained hernias)	6 (3.2)
				Scrotal hydrocele resolved with aspiration	3 (1.6)
				Bladder injury	2 (1.0)
				Abdominal bloating	1 (0.5)
				Urinary retention	1 (0.5)
				Thigh pain	1
				Pelvic ostitis	1 (0.5)
Transabdominal preperitoneal repair with prosthesis	328/359	32 to 84 yr avg 52.5 yr	13 to 104 wk avg 5 mo	Recurrence (2—questionable)	3 (0.84)
				Hematomas	11 (3.0)
				Scrotal	7
				Trocar insertion site	2
				Inguinal preperitoneal space	2
				Thigh pain	8 (2.2)
				Emphysema of scrotum	8 (2.2)
				Urinary retention	7 (1.1)
Extraperitoneal repair using video	53/90	27 to 75 yr avg 45 yr	3 to 40 wk avg 7 mo	Recurrence	0 (0)
				Hematomas	6 (6.6)
				Inguinal canal	5
				Anterior abdominal wall	1
				Testicular pain	1 (1.1)
Total repair of inguinal hernia with a large prosthesis	563/635	13 to 84 yr avg 48.5 yr	3 to 104 wk avg 5.6 mo	Recurrences	9 (1.4)
				Hematoma	17 (2.6)
				Thigh pain	9 (1.4)
				Emphysema of scrotum	8 (1.2)
				Urinary retention	8 (1.2)
				Scrotal hydrocele	3 (0.4)
				Bladder injury	2 (0.3)
				Pelvic ostitis	1 (0.15)
				Abdominal bloating	1 (0.15)
				Testicular pain	1 (0.15)

months. One patient (1.1%) had a mesh prosthesis that migrated into the scrotum, and another patient (1.1%) had a bladder injury that was recognized and repaired in an open procedure. One patient (1.1%) developed a hydrocele of the scrotum that resolved in 3 weeks after weekly aspiration. The total complication rate in this group was 13.5%. The third type of repair included those patients who had suture repair

of the iliopubic tract to Cooper's ligament. The average follow-up was less than 6 months, and one hydrocele (3.3%) developed, along with one bladder injury (3.3%) that occurred intraoperatively and was repaired at the time of inguinal herniorrhaphy. Two procedures (6.6%) were converted to an open operation because the iliopubic tract was not adequately visualized. The overall complication rate in this group was 19.8%, and the majority of surgeons described the operation as technically challenging. In the fourth type of repair, placement of a large prosthesis covering the entire myopectineal orifice (Fig 1) was placed on the peritoneum by the intraperitoneal patch onlay method (IPOM) or in the retroperitoneal space by either the transperitoneal application of preperitoneal mesh (TAPP) or by the total extraperitoneal method. The average follow-up was 5.6 months in this group. In the IPOM subset of patients (Table 6),[17] the average age was 48 years, and there were 182 patients with 186 hernias observed for an average of 5 months. Three patients (1.6%) developed scrotal hydroceles that resolved in 3 weeks after weekly aspiration. There were 2 patients who developed bladder injuries (1.0%) that were recognized and repaired at the time of surgery. Postoperative abdominal bloating developed in 1 patient (0.5%), urinary retention (0.5%) and lateral thigh pain in 1 patient (0.5%). An additional patient (0.5%) had postoperative pelvic osteitis, and the overall complication rate was 7.3%.

A second subset of patients had the TAPP procedure (Table 6),[17] 328 patients had 359 hernias with an average age of 52.5 years who were observed for an average of 5 months. Complications included 11 hematomas (3%), 7% of which were located in the scrotum, 2% at the trocar insertion site, and 2% in the retroperitoneal space. Lateral and central upper thigh pain or numbness developed postoperatively in 8 patients (2.2%), emphysema of the scrotum occurred in 8 patients (2.2%), and urinary retention was observed in 7 patients (2%). When emphysema of the scrotum developed during the operation, it spontaneously resolved in 2 to 3 days, whereas thigh pain or numbness required 3 to 4 weeks to resolve. The overall complication rate in this group was 9.3%.

The third category of the fourth type of inguinal repairs in this series consisted of 53 patients with 90 hernias whose repair was totally extraperitoneal (Table 6).[17] The average patient age was 45 years, and they were observed for an average of 7 months. Six (6.6%) postoperative hematomas developed, of which 5 were located in the inguinal canal and 1 in the anterior abdominal wall. All of these hematomas resolved in less than 4 weeks, and 1 patient had testicular pain (1.1%) that resolved in less than 3 weeks, resulting in a total complication rate of 7.7%. Overall, the complication rate in the fourth type of laparoscopic inguinal hernia repair was 9% (Table 6).[17]

These data have been corroborated by Fitzgibbons et al[19] in 702 patients with 888 hernias. These operations included IPOM, TAPP, and extraperitoneal placement of a prosthesis, and the overall complication rate in that series was 5%. As noted by MacFadyen et al,[17] bleeding of the abdominal wall or hematoma formation was most frequently observed, and in the Fitzgibbons series, the average was 4.4%. Bowel perforation was observed in 2 patients in Fitzgibbons series,[19] and 1 bladder injury required laparotomy for treatment. General complications occurred in an average of 7.1% of the patients, the vast majority were related to urinary tract complications (5.6%). One patient had severe right lower quadrant pain and adhesions, and 1 additional patient had a postoperative myocardial infarction and mortality on day 5, overall mortality was 0.1%. Complications related to the herniorrhaphy itself occurred in 21.2% of the patients. Most of these were related to minor transient groin pain (5.9%), seroma (3.7%), transient leg pain (3.3%), hematoma (2.1%), transient cord and testicular pain (1.2%), and persistent groin and testicular pain (2.1%). He also noted that 94% of all patients were discharged within 24 hours of the procedure. In this series, the incidence of postoperative neuralgia involving the lateral femoral cutaneous or genitofemoral nerves occurred more frequently in the first 10 cases of the surgeon's experience. This problem can be decreased greatly by not stapling the prosthesis in the region of the external iliac vessels and inferior to the lateral aspect of the iliopubic tract. Small bowel obstruction has also been observed when the synthetic mesh contacts the small intestine. Therefore, careful peritoneal closure after the TAPP procedure will significantly decrease this problem.

Other data have been reported by Tetik and Arregui[20] of 1,330 laparoscopic procedures where the prosthetic mesh was placed intraperitoneally or retroperitoneally. The overall complication rate was 14.59% with the IPOM procedure having a rate of 13.4%, the totally extraperitoneal approach 19.69%, and the TAPP operation 11.03%. Fiennes et al[21] had 19 complications in 178 laparoscopic inguinal herniorrhaphies for an overall complication rate of 10.67%. Neufang et al[22] reported on 259 laparoscopic hernia

repairs and noted only 5 complications that included dislocation of a prosthetic plug (1), injury of the vas deferens (1), infection (1), small bowel obstruction (1), and postoperative bleeding (1) with an overall incidence of 1.93%.

From these reports of 3,288 laparoscopic inguinal herniorrhaphies, there were 552 complications excluding recurrences for an overall complication rate of 16.8%. Although the data from Fitzgibbons et al can be excluded, thereby showing a complication rate of only 11.7%. It should be noted that his recording of data was extremely meticulous, and if all operations were evaluated similarly, complication rates may be reportedly higher. As reported for laparoscopic cholecystectomy,[23] the complication rate has decreased with experience and is similar to a large open series.[24] It is anticipated that laparoscopic inguinal hernia complications will decrease and be comparable with the rates of the open operations because this technique anatomically reinforces the entire region for potential inguinal hernia defects.

Although general anesthesia is required for the laparoscopic procedures, hospital discharge occurred in less than 24 hours. Local anesthesia allows for a more rapid discharge, and techniques are now being evaluated so that local anesthesia may be used in laparoscopy. A large prosthesis is necessary to cover the entire myopectineal orifice and mesh fixation is important, as noted by Stoppa et al[10] and Nyhus et al.[11] It is also important that, during the dissection of the myopectineal orifice, all fat over the muscle and fascia must be removed to allow direct contact and adherence between the prosthesis and the underlying muscle.

Postoperative neuralgias have been observed in open and laparoscopic inguinal hernia repairs. In the open technique, the ilioinguinal and genitofemoral nerves are more likely to be injured, whereas the lateral femoral cutaneous and genitofemoral nerves are most frequently contused or divided. As mentioned earlier, stapling or suturing close to the external iliac vessels and avoiding stapling lateral to the internal ring and inferior to the iliopubic tract markedly decrease the incidence of these problems.

Recurrence of Inguinal Hernias

The cause of primary inguinal hernias is a complex multifaceted process with many factors contributing to inguinal hernia recurrence. Always striving to prevent inguinal hernia recurrences, surgeons have developed a variety of effective open herniorrhaphy techniques. The principles of hernia repair have been incorporated into the evolving laparoscopic herniorrhaphy, and the issue of recurrence is particularly important. Recurrences do occur, and it is important for the surgeon to be aware of the rates of recurrence before undertaking any inguinal hernia repair. The incidence of recurrence after open inguinal herniorrhaphies varies from 1% to 7% for indirect inguinal hernias, 4% to 10% for direct inguinal hernia, 1% to 7% for femoral hernias, and 5% to 35% for recurrent inguinal repairs.[15] Tables 7 and 8[16] summarize that the overall rates of recurrence for open herniorrhaphies ranged up to 25% when performed by many surgeons using a variety of techniques. As previously emphasized,[2] in the pediatric age group less than 1% of inguinal hernias recurred.

Wantz[9] reported his own results using the Shouldice hernioplasty with an overall recurrence rate of

Table 7. Recurrence Rates After Various Repairs of Groin Hernias

Authors	*Techniques*	*No. Hernias Operated On*	*Control Rate (%)*	*Follow-up Duration (yr)*	*Recurrence Rate (%)*
Baumber*	Lytle	234		6-11	12.2-16
Bellenger*	Bassini	1,102	33.2	14	25.0
Callum*	Bassini	186		5-12	7.5
Clear*	Halsted I	1,048			11.0
Magarey*	Conjoint—IPT	192	87.0	0.5-14.0	3.1
Madden*	Bassini	2,374			1.9
Palumbo (1971)	Retrofunicular overlap	3,572			1.7
Piper*	Herniorrhaphy	435	72.0	1-6	15.8
Sheibe*	Bassini	309			2.6
Warlaumont (1982)	Bassini	91	89.3	1-10	15.8
Vavre*	Bassini	305			7.2

Abbreviation: IPT, iliopubic tract.
*Cited in Stoppa and Houdard, 1984.
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Table 8. Recurrence Rates After Herniorrhaphies That Used Multiple Techniques

Authors	*Techniques*	*No. Hernias Operated On*	*Control Rate (%)*	*Follow-up Duration (yr)*	*External Oblique*	*Direct*	*Recurrence Rate (%)*
Berliner (1984)	Bassini, McVay	723	93.7	4-9			11.5
	FT plasty	591		2.5			2.7
	Shouldice	326					0.3
Doran*	McVay	20	97.0	2			15.0-20.0
	Bassini	83					8.7-13.0
Hagan*	Halsted	766					6.7
	Bassini						2.9
	Ferguson						4.5
	McVay						6.6
	Lytle						3.6
Jones*	McVay	74		2			10.9
	Shouldice	222		2			4.5
Jungdahl*	Nyhus	402	90.3				6.4-16.7
	Bassini		88.9	1-5			1.5-16.7
Lubeth*	McVay	800	52.4				3.9
	Bassini	25					20.0
Marsden*	Morisson	265 + 75 + 15			6.5	8.0	20.0
	Bassini (nylon)	235 + 101 + 31			4.25	4.0	
	Bassini (gut)	104 + 19 + 3			7.7		
Warlaumont (1982)	Bassini	91	85.7	1-10			22.5
	McVay	373	85.1	1-10			15.5
Telle*	Bassini	612					10.1
	Halsted	88					13.9
	McVay	235					14.4
	McVay + Halsted	33					12.1
							10.8

Abbreviation: FT plasty, fascia transversalis plasty.
*Cited in Stoppa and Houdard, 1984.
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2.12% that included a 1.3% incidence for primary repairs and a 6.36% re-recurrence rate. When Stoppa[16] reviewed the data of other surgeons using the same technique, low recurrence rates were noted with a range of 0.18% to 2.6% (Table 9). This compared favorably with the Shouldice Clinic data for first recurrent hernias where the rate was 2.3%, and in patients with three to six recurrent hernias the recurrence rate was 11.4%.[25] Glassow reported his own recurrence rate, using the Shouldice technique, of 0.7%.[26]

Rutledge[8] reported on Cooper's ligament hernia repairs in 942 patients with 1,142 hernias that the overall recurrence rate was 2% with a 9 year follow-up, re-recurrent hernias accounted for a rate of 2.4% and the primary hernia group was 1.9%. When the results of the primary group were studied more carefully, the rates of recurrence for repair of direct and indirect hernias was 3.5% and 1.1%, respectively. Only 22.2% of the recurrences developed in the first 5 years after surgery and 27.8% occurred in 10 years.[8] Similarly, Stoppa,[16] in his evaluation of the Cooper's

Table 9. Recurrence Rates After Shouldice Repair

Authors	*Remark*	*No. Hernias Operated On*	*Control Rate (%)*	*Follow-up Duration (yr)*	*Recurrence Rate (%)*
Devlin*				6	0.8
Iles (1979)		30,940	95	1-16	1.1
Myers*		953	100		2.6
Obney*		114		1-20	1.0
Ryan*	Recurrent hernia	369	58	4	1.3
Shearburn*		550	96		0.18

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Table 10. Recurrence Rates After Cooper's Ligament Repair

Authors	*Associated Technique*	*No. Hernias Operated On*	*Control Rate (%)*	*Follow-up Duration (yr)*	*Recurrence Rate (%)*
Coste*		107		3	9.3
Estes*	OE myoplasty	400		5	1.5
Galesne*		872	75.3		12.2
Halverson & McVay (1970)		1,211	91.3	1-22	3.5
Kark*		159		1-2	2.5
Lund*		364	78.0	5	6.0-16.0
McVay (1978)		580	91.0	1-11	2.2
Rutledge*		758	96.0	6	1.4

Abbreviation: OE, obliquus externus.
*Cited in Stoppa and Houdard, 1984.
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ligament repair, showed an incidence of recurrence that ranged from 1.4% to 16% (Table 10). Of the 31 femoral hernias he repaired, Rutledge[8] reported no recurrences, whereas Stoppa[16] observed femoral hernia recurrences as high as 6% (Table 11).

Nyhus et al[11] initially reported 8 (6.9%) recurrences in 115 patients using the preperitoneal buttress technique suturing the iliopubic tract to Cooper's ligament. However, only 2 (1%) hernias recurred when the technique was modified to incorporate prosthetic mesh to cover the myopectoneal orifice. When using mesh for his preperitoneal buttress repair, Stoppa reported a 2% recurrence rate.[10,16] Whereas other investigators in Stoppa's[16] review reported a recurrence rate ranging from 0% to 13.3% (Table 12).

For inguinal hernia repairs using synthetic mesh placed anteriorly, Shulman et al[14] reported a 0.2% incidence of recurrence. Amid, Shulman, and Lichtenstein[27] in their review of 3,125 patients reported only 4 recurrences, all of whom had their hernias repaired early in the evolution of their technique. In a review by Stoppa[16] of similar operations performed by other surgeons, the recurrence rate ranges from 0% to 12.2% (Table 13).

The reasons for recurrence have included tension and ischemia at the suture line, weak fixation tissue, and a missed hernia at the initial operation.[28] Berliner,[29] a proponent of the Shouldice repair, has hypothesized that close approximation of the wound edges during hernia repair causes contact inhibition of fibroblasts thereby decreasing adequate collagen production. This problem is overcome by plication or inversion of the wound edges, preventing contact and allowing the fibroblasts to function maximally. Ambulation creates early mechanical stress on the wound, and thus, maintains the correct electrical charge on collagen fibers allowing them to orient in their strongest configuration as healing proceeds.

When the IPOM, TAPP, and totally extraperitoneal laparoscopic hernia techniques are used, MacFadyen et al[17] have reported an overall recurrence rate of 1.4% in an average follow-up of 5.6 months, in which five recurrences were direct and four indirect.

Table 11. Recurrence Rates in Femoral Hernias

Authors	*Techniques*	*No. Hernias Operated On*	*Control Rate (%)*	*Follow-up Duration (yr)*	*Recurrence Rate*
Bagot Walters*	Preperitoneal approach	114	79.8	2-21	1 recurrence
Glassow*	Femoral approach	1,143			2%
	Shouldice	265 (65)			6%
Glassow*	Femoral approach	625			1.3%
Hagan*	Femoral approach	62	71.0	2-5	1 inguinal recurrence
Halverson & McVay (1970)	McVay	107			3.73%
Lund*	McVay	26			0
		3 inguinal hernias associated			2 recurrences

*Cited in Stoppa and Houdard, 1984.
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Table 12. Recurrence Rates After Preperitoneal Prosthetic Repairs

Authors	*Techniques*	*No. Hernias Operated On*	*Control Rate (%)*	*Follow-up Duration (yr)*	*Recurrence Rate (%)*
Blondiaux (1979)	Teflon, mid ap	91	52.7	0.5-3.5	0.0
Brismoutier*	Silicone, mid ap	101		4	6.0
Calne (1967)	Dacron, Pfannenstiel	30		1-7.5	13.3
Detrie*	Nylon, mid ap	50		0.5-4	0.0
Fagot*	Dacron, mid ap	29	100.0	0.5-3	1.3
Gosset (1972)	Rhodergon-Velvet, mid ap	7		2	0.0
Read (1975)	Marlex, mid ap	83		4	7.0
Rignault (1983)	Dacron, Pfannenstiel	658	86.3	4	4.6
Saint Julien†	Dacron, mid ap	309	63.3	0.5-6	2.9
Stoppa (1973)	Dacron, mid ap	168	88.1	1-7	3.3
Warlaumont (1982)	Dacron, mid ap	285	91.3	1-10	1.2

Abbreviation: mid ap, midline approach.
*Cited in Stoppa and Houdard, 1984.
†Cited in Salinier, 1983.
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The IPOM technique had a 3.2% recurrence rate with a follow-up of less than 5 months, whereas the TAPP procedure had a recurrence rate of only 0.84% with a 5 month follow-up. No recurrences occurred within 7 months of follow-up for the totally extraperitoneal technique. A 6.6% incidence of recurrence was noted with the laparoscopic transperitoneal suture repair of the iliopubic tract to Cooper's ligament.

On the other hand, Fitzgibbons et al[19] found an overall recurrence rate of 3.6% for all laparoscopic techniques using mesh, covering the entire myopectoneal orifice, and follow-up was longer at a mean of 13.5 months, with a re-recurrence rate of 3.2%. In this series, the recurrence rate for the IPOM was 3.7% and for the TAPP, 4.2%. Again, no recurrences developed in the totally extraperitoneal technique. A learning curve was observed in this report[16] whereby the incidence of recurrence decreased after the first 10 cases but then rose sharply for cases 51 to 60. This may be secondary to a surgeon's overconfidence.

Tetik and Arregui[20] reported an overall 2.2% incidence of recurrence in 1,514 laparoscopic hernia repairs with an average follow-up of 13 months. However, when only synthetic mesh procedures were considered, the rates of recurrence for the IPOM, TAPP, and totally extraperitoneal procedures were 2.2%, 0.7%, and 0.4%, respectively. Fiennes and Taylor,[21] in their study of 178 laparoscopic hernia repairs, showed recurrences in 6 patients (3.4%). Neufang et al[22] reported an overall recurrence rate of

Table 13. Recurrence Rates After Inguinal Patch

Authors	*Techniques*	*No. Hernias Operated On*	*Control Rate (%)*	*Follow-up Duration (yr)*	*Recurrence Rate (%)*
Bapat*	Steel	95	84.2	0.5-5.5	1.0
Barthes (1971)	Nylon	273		3	9.9
Cerise*	Dacron	100	100.0	1-4.5	1.0
Courtot*	Rhodergon	31		1	7.0
Martin*	Marlex	365		1-10	0.0
Nahas*	Nylon	51			2.0
Notaras*	Dacron	246		1-8	0.4
Piper*	Skin	246	67.7		12.2
Rives (1978)	Dacron	65			0.0
Rives (1982)	Dacron	183	66.1	1-9	1.6
Saliba*	Dacron	204			0.0
Snidjers*	Teflon	150	93.0	1-8	2.7
Warlaumont (1982)	Dacron	208	87.3	1-10	10.9
Usher*	Marlex	541	44.4	1	10.2
Zagdoun (1959)	Nylon	185	80.0	1-7	7.0

*Cited in Stoppa and Houdard, 1984.
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Table 14. Summary Data of Laparoscopic Inguinal Herniorrhaphy

	No.
Patients	3,288
Complications	552
Overall complication rate	16.8%
Patients	3,178
Recurrences (follow-up > 6 mo)	61
Overall recurrence rate	1.92%

12% for the laparoscopic repair of 259 inguinal hernias. The incidence of recurrences in this series was 1.6% for procedures that used the preperitoneal placement of a large piece of mesh.

From these reports, 3,178 laparoscopic inguinal herniorrhaphies were performed using either the IPOM, TAPP, or totally extraperitoneal procedure (Table 14). There were 61 recurrences for an overall recurrence rate of 1.92%. This incidence of recurrence would be higher if the data from the laparoscopic suture repair and plug and patch methods were included. However, early experience has shown excessively high incidences of recurrence associated with these procedures, and they are now rarely performed. As surgeons gain more experience with laparoscopic preperitoneal placement of prosthetic mesh, the incidence of recurrence will become even smaller.

Conclusions

In conclusion, the laparoscopic inguinal hernia recurrence rate is low when large prosthetic mesh is placed as in the IPOM, TAPP, and totally extraperitoneal techniques. However, the longest average follow-up to date is only 13 months,[16] and most investigators agree that a longer follow-up is necessary to accurately determine the true recurrence rate. These data will be forthcoming over the next 3 to 5 years. Stoppa[10,16] has emphasized that recurrences in the first 6 months are technical failures, whereas recurrences after that time are related to collagen breakdown. As has been shown from the open data in the preperitoneal repair from Stoppa's data[10,16] and Nyhus' data,[11] a large prosthesis covering the entire myopectineal orifice will minimize recurrences from collagen breakdown.

Most recurrences after laparoscopic inguinal hernia repair have been related to inadequate fixation of the prosthesis, too small a piece of mesh, and inadequate adherence of the mesh to the underlying muscle and/or fascia. These technical considerations allow for the redevelopment of a hernia underneath the edge of the prosthesis and also increase the likelihood of small bowel obstruction. As is true with any new procedure, as the surgeon gains experience, these technical problems will greatly decrease.

It is apparent from these data that the complication rates of open and laparoscopic inguinal hernia repairs are similar when a large piece of mesh is placed in the preperitoneal space covering the entire myopectineal orifice. On the other hand, general anesthesia, and its attendant morbidity, is required for laparoscopic techniques as opposed to local anesthesia in open operations. However, newer technical equipment using balloon technology may expedite the extraperitoneal dissection and, therefore, allow the use of local anesthesia during laparoscopy. In addition, it may be that the totally extraperitoneal approach will minimize the potential for intraperitoneal injury and, therefore, decrease complications thereby making this procedure truly minimally invasive.

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