Anatomical and surgical considerations for minimally invasive surgery of adnexal mass lesions

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Summary

During the past decade, minimally invasive surgery has become a part of almost every surgical field. The gynecologic surgeons were among the first to recognize the potentials of laparoscopic approach for management of various benign gynecologic problems. The laparoscopic approach offers several advantages over laparotomy. Pelvic and abdominal anatomy appears magnified, allowing precise diagnosis and treatment of the disease adjacent to vital organs, blood vessels, and nerve structures. Additional benefits of laparoscopic approach include minimized bleeding from small vessels afforded by pneumoperitoneum, the elimination of large abdominal incision, less adhesion formation, early ambulation and faster recovery, shorter hospital stay, and less cost to the patient and hospital. Although clinical examination and the results of preoperative work-up often indicate the benign or malignant nature of the adnexal mass, only histology can provide the absolute diagnosis. When malignancy is detected, immediate surgical staging by laparoscopy or by laparotomy is indicated. Operative laparoscopy for evaluation and management of adnexal masses, when performed by a surgeon trained in advanced laparoscopic techniques, is safe and effective and associated with less morbidity compared with open techniques. [*Noriega J, Escobar PF. Anatomical and surgical considerations for minimally invasive surgery of adnexal mass lesions. MedUNAB 2005; 8:151-158*].

Key words: Laparoscopy ,ultrasonography, adnexal mass, Doppler, Color Doppler, CA-125, ovarian cancer, transvaginal ultrasound.

Resumen

Consideraciones anatómicas y quirúrgicas de la cirugía mínimamente invasiva de las masas anexiales. Desde la década pasada la cirugía minimamente invasiva ha llegado a ser parte de casi todos los campos quirúrgicos. El ginecólogo estuvo entre los primeros en reconocer el potencial del abordaje laparoscopico para el manejo de varios problemas ginecológicos benignos. La laparoscopia ofrece varias ventajas sobre la laparotomía. La anatomia pelvica y abdominal aparece magnificada permitiendo un diagnostico y manejo preciso de la enfermedad adyacente a órganos vitales, vasos sanguíneos y estructuras neurales. Beneficios adicionales de la laparoscopia incluyen sangrado mínimo de los pequeños vasos ayudado por el pneumoperitoneo, eliminación de grandes incisiones, menos formación de adherencias, deambulacion temprana y rápida recuperación, corta estancia hospitalaria y menos costos para el paciente y hospital. Aunque el examen clínico y los resultados del estudio prequirúrgico frecuentemente indican la naturaleza benigna o maligna de de las masas anexiales, solo la histología puede proveer el diagnostico absoluto. Cuando un tumor maligno es detectado de inmediato se debe realizar una clasificación del estadio por laparoscopia o laparotomía. La laparoscopia operatoria para evaluación y manejo de masas anexiales cuando es practicada por un cirujano entrenado en cirugía laparoscopica avanzada es segura ,efectiva y asociada con menos morbilidad comparada con las técnicas abiertas.

Palabras clave: Laparoscopia, ultrasonografia, masa anexial, Doppler, Doppler color, cancer ovárico, ultrasonografia transvaginal.

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Introduction

During the last 25 years, the field of gynecologic endoscopy has advanced tremendously. Advantages of minimally invasive surgery include, shorter hospitalization, cosmetic benefits to the patient, less postoperative complications, and improved recovery time.[1-4] The proven clinical applications of minimally access surgery have led to the development of more advanced operative laparoscopic techniques for a wide spectrum of gynecologic diseases. One issue of great interest and importance is laparoscopic surgery of adnexal masses. The management of preoperative suspicious adnexal masses still controversial, their remains no clear conclusion regarding the optimal preoperative evaluation and form of laparoscopic management in this patients. This brief review will try to outline some key aspects of minimally invasive surgery for adnexal mass lesions.

Anatomical considerations

A thorough knowledge of anatomy is required to understand the potential therapeutic roles of operative laparoscopy in the management of adnexal mass lesions as well as its limitations, and complications. The risk of surgical complications is linearly correlated with surgical technique, instrumentation, and knowledge of relevant anatomy. There are normal variations of pelvic and abdominal anatomy. In order to describe certain anatomic relationships in the pelvis and abdominal wall at laparoscopy and the effect of body mass index (BMI) on those parameters, Nezhat and coauthors[5] reported on clinical measures of distances from the midline to inferior epigastric vessels, ureter and infundibulopelvic ligament in 103 patients.

They showed that the right ureter was anatomically significantly closer to the infundibulopelvic and uterosacral ligaments than the left ureter. They also showed that the right inferior epigastric vessels and umbilical ligament coursed more laterally than did those on the left. One finding of great interest and importance is that both sets of inferior epigastric vessels, and the left umbilical ligament and ureter were significantly more difficult to identify in overweight women.[5]

The proximity of the ureter and major vessels to the uterosacral and infundibulopelvic ligaments reaffirms the need to identify and dissect these structures during surgery for adnexal masses and requires knowledge of relevant pelvic sidewall, and retroperitoneal anatomy. The retroperitoneal space contains the major neural, vascular, and lymphatic supply to the pelvis. The space is usually not affected by adhesions or gynecologic diseases. It is of paramount importance for the minimally invasive surgeon to be able of use this plane of dissection when the peritoneal cavity or sidewall has become obliterated. This can be particularly daunting during complex operative laparoscopy since the electronically rendered two-dimensional

view and the optical element of magnification along with the effect of pneumoperitoneum and a steep. Trendelemberg position gives pelvic anatomy during laparoscopy a different appearance.[5]

Veress needle and trocars-induced vascular injuries are serious complications that occur in 0.2 to 2% of laparoscopic surgery.[6-9] The superficial and deep inferior epigastria vessels provide the main blood supply to the lower abdominal wall. Both of these vessels are at risk of tracer related injuries. In an interesting anatomical study, El-Markey and coauthors reported on the micro dissection of the inferior epigastria artery, its main branches, and the perforator vessels in 20 cadavers. The inferior epigastria artery was found to be associated with two veins in 90% of the cases. They also showed that the lateral division of the deep inferior epigastria artery and the perforator vessels it gives are more dominant than the medial perforators.

During operative laparoscopy is routine to placed tracers lateral to the midline, therefore, increasing the risk of vascular injuries. Hard and coauthors retrospectively reviewed abdominal computed topographic images of 21 reproductive-aged women at an academic center to determine the location of the inferior epigastria, superficial epigastria, and superficial circumflex iliac arteries in relation to the syphilis pubis, the umbilicus, and the abdominal midline. They found that above the syphilis the inferior and superficial epigastria arteries were 5.6±1.0 cm (mean ± standard deviation) and 5.5±2.0 cm from the midline, respectively. Although the location of these two vessels correlated (r = 0.6, p = 0.02), the mean difference in their location was 1.4±1.1 cm. and concluded that when laparoscopic landmarks are not visible to guide placement, lateral tracers should be placed approximately 8 cm from the midline and at least 5 cm above the syphilis to minimize the risk of vessel injury.[10]

In a more recent prospective clinical descriptive study by Quaint et al the location and number of abdominal wall vessels visible by Tran illumination were recorded for 68 patients of various weights undergoing laparoscopy for different clinical indications. Superficial abdominal wall vessels were located by Tran- illumination in the majority of women of normal weight regardless of skin color, it was however of less value in overweight and obese women. More importantly was the fact that the deep inferior epigastria vessels were not effectively located by Tran illumination, Quaint and coauthors concluded that other techniques should be used to minimize the risk of injury to these vessels.[11]

Recently, Saber and coauthors[12] determine the efficacy of CT scan in mapping the superior and inferior epigastria vessels, relative to landmarks apparent at laparoscopy. The authors reviewed abdominal and pelvic CT images of 100 patients, and determined the location of the superior and inferior epigastria vessels from the midline at five levels, correlated with each other and with the patient age, and body mass index. The authors concluded that the

epigastria vessels are usually located in the area between 4 and 8 cm from the midline depending on the landmark being used for the measurement.

The inferior epigastric vessels are branches of the external iliac vessel. They coursed cephalad between the abdominal wall peritoneum and the rectus muscles .They are found lateral to the obliterate umbilical vessels and medial to the deep inguinal ring, which can be identified. Transillumination will not help delineate the inferior epigastric vessels. Direct visualization is necessary. There are usually three vessels; two veins and one artery. In patient where the vessels can be visualized, the trocars can be placed lateral to the rectus muscle (8 cm from the midline) and approximately 4-5 cm above the symphysis pubis. Date from computed tomography have shown that the mean distance from the middle to the inferior epigastric vessels is 5 cm at 3 and 5.2 cm at 5 cm above the symphysis pubis.

The superficial abdominal vessels (superficial epigastric vessels and superficial iliac arteries) are branches of femoral artery. At 5 cm above symphysis pubis the superficial epigastric vessels are 5.2 cm from midline and the superficial circumflex iliac vessels are 9.5 cm from the midline. These vessels can be transilluminated in thin patient. Clearly, both the superficial and inferior epigastria abdominal wall vessels are at risk from tracer related injuries in gynecologic surgery. The superficial vessels can be accurately located by Tran illumination; however, the inferior epigastria vessels cannot be located using that technique. The combination of anatomical landmarks apparent at laparoscopy, awareness of normal anatomical variation and thorough knowledge of pelvic anatomy will determine the safe zone of entry of the anterior abdominal wall (figure 1).
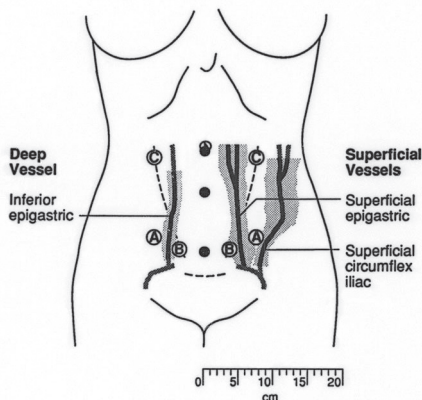
Although, neuropathies are infrequently associated with major pelvic surgery, it is important to minimize potential nerve injury during lower abdominal tracer placements. Knowledge of the variations in the course of the iliohypogastric and ilioinguinal nerves is of practical clinical importance. Injury to these nerves is usually herald by intense burning pain in the lower abdomen, upper medial thigh, and pelvic region, with altered skin sensations in these same areas.

Whiteside and coauthors[13] dissected eleven fresh frozen cadavers and located the entrance and termination points of 13 iliohypogastric and 16 ilioinguinal nerves. The authors concluded that there is great variation in the course of these nerves and surgical incisions or trocars placements below the level of the anterior superior iliac spine have the potential for ilioinguinal or iliohypogastric injury. Ilioinguinal and iliohypogastric nerve injury is the second most common source of post-operative neuropathy following major pelvic surgery. The most common source of neuropathy is obturator injury (figures 2 and 3).[14]
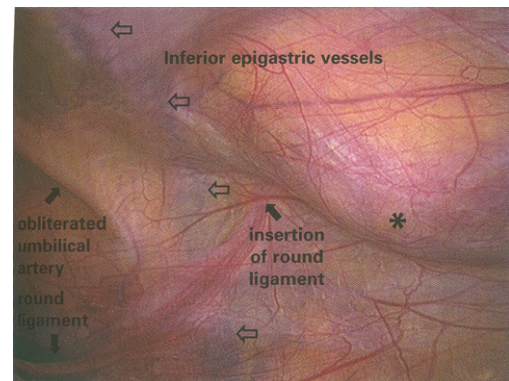

Figure 2. Location of inferior epigastric vessels in anterior abdominal wall and relationship with round ligament and obliterated umbilical artery. (Courtesy Dr Tomasso Falcone)
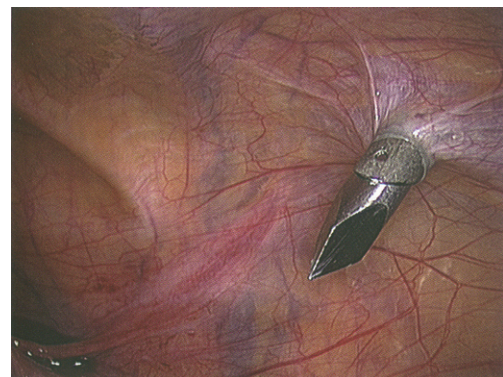

Figure 1. Relationship of the anterior abdominal wall vessel to potential entry sites for trocars.

Figure 3 .The auxiliary trocars insertion in the iliac fosse lateral to the inferior epigastric vessels. (Courtesy Dr Tomasso Falcone)

As laparoscopy is used increasingly for evaluating complex adnexal masses, its potential limitations and complications must be understood. It is well known that more complex laparoscopic procedures are proportionately associated with greater rates of operative complications, conversions to laparotomy, and postoperative admissions to the hospital.[15] Moreover, the risk of complications increases with the level of surgery and decreased with surgeon's experience and expertise.[16]

Operative techniques

Even though, laparoscopic procedures carry a steep learning curve, numerous minimally invasive surgical techniques for adnexal mass lesions have been developed over the years. Laparoscopy is a safe approach to adnexal masses, and may decrease unnecessary laparotomies, all this in well selected patients and in experienced hands. It has been shown that the establishment of a comprehensive gynecologic endoscopic hospital privileging program is associated with a reduction in rates of excess blood loss, operating times and a decreasing trend in visceral injuries.[18]

The operative approach to the pelvic mass has routinely been via laparotomy. This provides for early detection, resection, and proper staging, should ovarian cancer found. Advancement in laparoscopic diagnosis and management have decreased the morbidity of exploratory laparotomy in some patient; however, controversy has erupted over which patient are considered appropriate for the procedure. However most adnexal masses in premenopausal and postmenopausal women are benign. In women operated on for presence of pelvic mass various studies have reported findings malignancy in 7% to 13% of premenopausal and 8% to 45% of postmenopausal patients.[19]

The incidence of unsuspected ovarian cancer at laparoscopy has been shown to be only 0.04 % by Nezhat et al[20] and a 1990 survey of the American Association of Gynecologic Laparoscopist.[21]

Preoperative evaluation

The patient's age, the clinical exam, and ultrasound findings provide an important information that help to determine the operative approach. Postmenopausal women should also have serum CA-125 value determined (table 1).

Age. Ovarian cancer has a bimodal age distribution: the very young and very old are much more likely to have an ovarian malignancy than those patient who are of reproductive age. Among children and adolescents with complex adnexal masses, the most common neoplasm is a teratoma; the most common malignancy is a dysgerminoma.

Table 1. Patient selection strategies

-      History
-      Tumor markers
-      Physical exam
-      Menopausal status
-      Imaging studies

The differential diagnosis for adnexal masses in young patients include benign (follicular and corpus luteum cysts and teratomas) and malignancy (germ cells and stromal) origins. The symptoms associated with this masses (i.e., hormonal activity)often are critical to the correct diagnosis. Patients in the reproductive-age group are far less likely to have malignancy, even with the classic findings or complex adnexal masses. Cystic masses include tubo-ovarian abscesses, hydrosalpinx, bicornuate uterus, bowel, bladder, and pelvic kidneys. Solid masses include myomas, appendiceal abscess, abdominal wall hematomas, and retroperitoneal tumors. False-positive results reduce the specificity and predictive value of any diagnostic test. Unfortunately, CA-125, the most sensitive marker for epithelial ovarian malignancy, is elevated in may other condition found in premenopausal patients, such as pelvic inflammatory disease (PID), endometriosis, uterine myomas, and pregnancy. Thus, CA-125 has high positive and negative value in postmenopausal patient. Postmenopausal patients with adnexal masses are far more likely to have a malignancy, either of ovarian, uterine or gastrointestinal origins. When presented with postmenopausal patient with adnexal mass, the physician must include gastrointestinal malignancy, uterine malignancy, and metastatic disease to the ovaries in the differential diagnosis.

Clinical examination. Physical examination was the ¨gold standard ¨used by barber and grabber in their landmark paper describing the postmenopausal palpable ovary.[22] The location, consistency, and contour of the mass often can be helpful in determining the likely origin of the mass. Adnexal masses that are fixed, irregular, and firm are suggestive of malignancy. An adnexal mass found in the presence of ascites or an upper abdominal mass is highly suspicious for cancer. A fixed mass may be caused by endometriosis or PID; however; this diagnosis should never be presumed in a postmenopausal. Several others caveats also must be considered. The possibility of the findings being caused by bladder distension or stool must be considered. If there is any question, the examination should be repeated (before surgical intervention) after empty the bladder or giving 2-day course of laxatives.

In addition to false-positive findings in the physical examination, the sensitivity of the pelvic examination itself has been called in question. Padilla et al found a sensitivity of 15% to 36% in patient already under general anes-

thesia who were about to undergo a surgical procedure. The ability to examine an adnexal mass may be further hindered by a pregnant uterus or patient discomfort. Every experienced clinicians knows that the patient who had experienced pain during a previous pelvic examination will be enable to allow other examiners to perform a deep palpation.[23]

Imaging studies. Ultrasound (US) evaluation of an adnexal masses continues to be the most widely used method. The examination can either be done transabdominally (with a full bladder) or transvaginally, which allow probe to be physically closer to the adnexal and does not require bladder filling. Occasionally, patient may be unable to tolerate the transvaginal approach, limiting the examination. Transvaginal exam is a able to achieve greater resolution and clarity of image, and thus is preferred over transabdominal exam.

Adnexal masses can be easily categorized into one of four patterns: cystic, multicystic, complex, or solid. These categories, along with notation regarding the patient's age and sonography criterias are helpful factors in order to indicate whether a mass is likely to be malignant or not. Sonographic findings of irregular borders, papillations, solid areas, thick septa, ascites or matted bowel raise concern regarding the possibility of malignancy. solid component within an ovarian mass is reported to be the most statistically significant predictor of malignancy.[24] Using ultrasonographic criteria, accurate predictions of benign masses were made in 96% of patients.[25, 26] Nezhat et al[20] found that none of the four malignant cysts in their series had any ultrasound criteria for malignancy. Laparoscopic diagnosis of adnexal masses that are suspicious on ultrasound, however, prevents many laparotomies for the treatment of benign masses.

Certain echo patterns are highly characteristic of benign pathology, but are not simple cyst. Typical US patterns exist that are highly accurate with regard to the final pathology such as: endometrioma, cystic teratoma, cystadenoma, adenofibroma as hydrosalpinx, as described Guerriero et al.[27] Cystic teratomas usually consist of cystic and solid components; the solid component often has shadowing below it. The solid component often has shadowing represents calcification which is found in up 70% of cyst teratomas. Despite the high accuracy of these specific US patterns in above diagnoses, there is still overlap between these benign situations and frank malignancy. For instances, the echo-dense area with posterior shadowing as found in cystic teratoma also may occur in the adenofibroma or malignancies, such as papillary serous ovarian carcinoma or low malignant potential tumors. Granulosa cell tumors may resemble endometriomas on two-dimensional (2D) ultrasound. The published literature found 2-D transvaginal ultrasound to be 85to 100% sensitive for identifying an adnexal mass as malignant.[28]

Doppler can be used to determine the presence and location of vascular flow. Masses with central vascular flow or vascular flow within excrescences are of concern for malignancy. Masses with doppler flow limited to the periphery are more likely to be benign. Initial reports using pulsed Doppler showed high sensitivity and specificity for detection of ovarian cancers, but subsequent studies have shown considerable overlap of resistive index (RI) and pulsatility index (PI) ratios in benign and malignant masses.[29, 30] Whereas RI and PI tend to be lower in malignant ovarian tumors, these indices cannot reliably differentiate benign from malignant masses because some benign tumors, inflammatory conditions, and the normal corpus luteum may have flow patterns similar to those found in ovarian malignancies.[31] The theory said low PI and RI would indicate decreased vascular resistance as one would expect with neovacularization of malignancies. However, the lack of reproducibility, lack of accuracy, and the overlap between benign and malignant masses have led several investigators to question the value of these types of Doppler measurements.[31] For this reason, pulsed Doppler cannot be used as an independent indicator of malignancy, but it may provide supplemental information that is useful in benign versus malignant differentiation.

Several multivariate logistic regression scoring systems have been developed for the evaluation of adnexal masses. Some investigators have developed a morphologic scoring system to standardize diagnosis of ovarian abnormalities (table 2). The scoring system or morphologic index assigns numerical scores for various US features, such as size, wall thickness (> 3 mm), solid components, and number and thickness of septations(> 3 mm). Excellent interobserver variability is reported with use of the morphologic index,[32] but Timmerman et al[33] found similar interobserver variability (Cohen´s kappa 0.85) when readers used subjective assessment of ovarian morphology (malignancy index: a function of CA-125 level, ultrasound scoring system, and menopausal status).

A more recent multivariate logistic regression analysis notes that the most important criteria for predicting malignancy are the presence of solid component within the central portion of the tumor and the presence of vascular

Table 2. Scoring system for adnexal masses[35]

Score	Capsule	Septa	Papillarities	Echogenicity
1	< 3mm	Absent	Absent	Sonolucent
2	> 3mm	Thin <3 mm		Low
3		Thick > 3mm		
4	Irregular, solid		<3 mm	With echogenic areas
5	Irregular		>3 mm	Nonhomogeneus solid

flow within the same area. These two criteria combined yielded a 92% sensitivity and 94% specificity.[34]

CA-125. Since the majority of ovarian malignancy are epithelial, the most important marker to date has been CA-125, an antigenic determinant that is expressed in neoplastic, but no normal, ovarian epithelium. Levels below 35 U/mL are associated with benign conditions, but sensitivity and specificity vary. Using a cutoff of 30 U/mL, the positive predictive value is 75%,and increase to 93% with cutoff of 65U/mL. Only 50% of patients with stage I ovarian cancers had elevated CA-125 levels, compared with 90% of women with stage II.[36]

Vasilev[37] found that 128 of 132 (97%) patients with pelvic masses who had a CA-125 < 35 UI/mL had benign masses. Eighty percent of patient over 50 years with elevated CA-125 had malignant masses. However, in patient under 50 years, 34 of 40 (85%) had benign masses. Endometriosis, fibroids, adenomyosis, cystic teratoma, and acute or chronic salpingitis may be associated with elevated levels. Due to the high false positive rate, the use of CA-125 values unnecessary exclude many premenopausal women who would benefit from operative laparoscopy. This is way this test for premenopausal women with an adnexal masses must be not perform. 80% of patient over age 50 who had a CA-125 levels > 35 mcg/mL had malignant masses. For this reason some authors find the CA-125 value helpful in preoperative evaluation of postmenopausal patient.

Accurate preoperative prediction of malignancy is import for patient counseling, as well as for selecting the optimal operative approach(laparoscopy versus laparotomy), and operative procedure (cystectomy versus oophorectomy)

Lynda et al[18] in a very interesting study showed that ultrasonographic tumor appearance and size are the best predictors of malignancy in premenopausal women, whereas CA-125 level and ultrasonographic appearance are the best predictors in postmenopausal women. The addition of Doppler sonography for cases in which the gray scale findings are suspicious is not recommended;

Table 3. Probability of disease based upon logistic regression analysis

	Premenopausal adnexal masses			
	Nonsuspicious		Suspicious	
Size	< 10cm	> 10 cm	< 10 cm	> 10 cm
Probability malignancy	< 1%	2,9%	36.5%	78.6%

	Postmenopausal adnexal masses			
	CA-125 < 100 U/ml		CA-125 > 100 U/ml	
	Ultrasound		Ultrasound	
	Nonsuspicious	Suspicious	Nonsuspicious	Suspicious
Probability malignancy	9.7%	34,4%	58%	87.1%

this results in a small improvement in positive predictive value at the cost of large decrease in sensitivity. Flinker and Jacobs[38] found similar findings that Linda`s study and gave the same conclusion. In figure 4 is our propousal about clinical and surgical approach to adnexal masses by laparoscopic surgery.

Clinical outcome

What are the clinical and survival outcomes associated with laparoscopic management of early ovarian cancer and adnexal masses though to be benign preoperatively? In order to answer this question, Havrilesky and coauthors[39] evaluated the clinical outcomes of 396 patients who underwent laparoscopic management of adnexal

Figure. 4. Preoperative evaluation
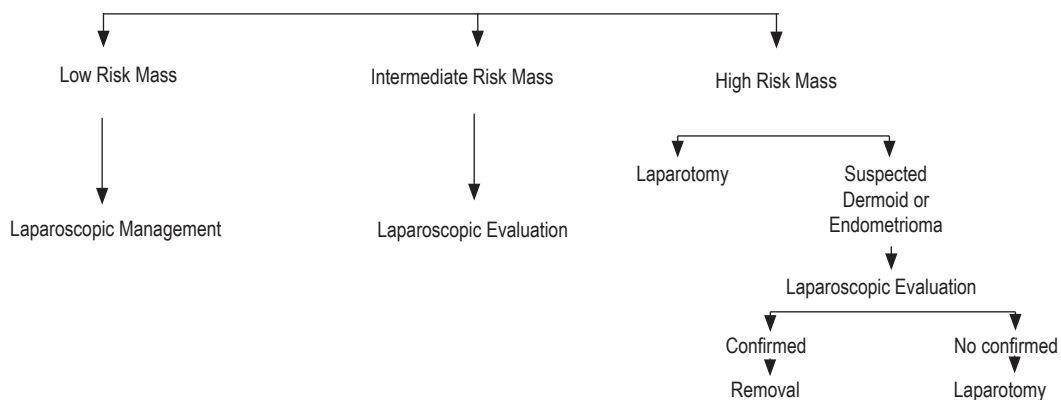
masses though to be benign preoperative. Conversion to laparotomy occurred in 25% of the patients as well as mass ruptured. This was associated with mass size and prior or concurrent hysterectomy. Blood loss, length of stay, and adverse events were all associated with concurrent hysterectomy. More importantly, malignancy occurred in 2% of the patients and laparoscopic management was not associated with adverse outcomes

Tumor spill

The intraoperatve rupture of stage I ovarian carcinomas does not seem not to affect prognosis. Stovall et al[38] reported the 10 year survival rates for 394 women with stage I and stage IIa In the 147 women who had the tumors removed with the capsule intact,78% survived 10 year. For the 47 women who had intraoperative puncture of the tumor and the 98 women who had intraoperative rupture of the tumor, the 10-year survival was 87% and 84% respectively. Seventyseven percent of women with intact tumors were treated postoperatively, compared with 90% of those with puncture o rupture. No patient with well differentiated tumor died, regardless of rupture or use of postoperative treatment. The authors concluded that neither intraoperative puncture nor rupture of the tumor had any impact on survival.

Conclusion

Careful patient selection can choose patient who are appropriate for management of an adnexal mass via operative laparoscopy. The development of sensitive tumor markers and transvaginal ultrasound has aided the clinician in identifying select patient who can be operated by laparoscopy. In addition, diagnostic and operative laparoscopies are now management options, even in postmenopausal patient. Proper intraoperative assessment and liberal used of rapid frozen section are also important. Reported studies show that laparoscopy management can be safely performed. Operative laparoscopy for evaluation and management of adnexal masses, when performed by a surgeon trained in advanced laparoscopic techniques, is safe and effective and associated with less morbidity compared with open techniques. The short hospital stay and rapid return to normal activity benefit patient care. However, when invasive cancer found at the time of surgery, the surgeon should be prepared to proceed with staging laparotomy for appropriate treatment.

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