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Review Article

Impact of Cystectomy on Ovarian Reserve: Review of the Literature

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ABSTRACT Ovarian cysts are common in the reproductive age. Pathologic cysts such as endometriomas and dermoids often require surgical intervention if symptomatic. Laparoscopic cystectomy is the first-line treatment for these cysts and is associated with better pain control and less recurrence than drainage or cyst ablation procedures. There has been an emerging concern about the effect of ovarian cystectomy on ovarian reserve with some evidence of short-term and long-term reduction in ovarian reserve. Certain cyst characteristics (endometrioma pathology, large cyst size, bilateral presentation) are associated with a greater decline in ovarian reserve after cystectomy. The impact of surgery on ovarian reserve can be minimized by selecting the appropriate surgery for the patient, careful tissue handling, and limited use of electrosurgery. Patients should be counseled on the risks of surgery on reproductive potential, and the management plan should be individualized to the patient's symptoms and reproductive goals. Journal of Minimally Invasive Gynecology (2017) 24, 247–257 © 2016 AAGL. All rights reserved.

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Ovarian cysts are common in reproductive-aged women. Most cysts are normal functional cysts that typically resolve spontaneously and do not require treatment. However, pathologic cysts such as endometriomas and dermoids may require surgical intervention. For reproductive-aged women with symptomatic ovarian cysts, laparoscopic cystectomy is the first-line surgical treatment for ovarian cysts because it offers multiple advantages, including the benefits of ovarian-sparing surgery (with ongoing hormonal support and preservation of future fertility) and of minimally invasive surgery (including small incisions, fast recovery, and less pain) [1–3].

Although cystectomy offers an ovarian-sparing procedure, there is still a concern about the effect of cystectomy on ovarian reserve. Studies have assessed cyst size, cyst pathology, cyst burden (unilateral vs bilateral presentation), and methods of obtaining hemostasis to identify the risk factors for diminished ovarian reserve after cystectomy. In this article we review the literature to assess the baseline impact of ovarian cysts on fertility and the potential effect of cystectomy on ovarian reserve. We examine endometrioma and nonendometrioma ovarian cysts, with a focus on ovarian dermoids for nonendometrioma cysts given the breadth of nonendometrioma cyst types.

Ovarian Reserve

Definitions

Ovarian reserve is the reproductive potential of the patient at a certain point in time. Several definitions for ovarian reserve have been described in the literature and are also provided in Table 1 [4–7].

A woman's reproductive potential is determined by the resting primordial follicles that can develop into primary, antral, and ovulatory follicles [8] (Fig). Ovarian reserve is most affected by age. Cigarette smoking, exposure to radiation or chemotherapy, and genetic factors are also believed to play a role [9]. It has also been hypothesized that adnexal surgeries such as ovarian cystectomies may impact ovarian reserve [10,11].

Measurement Tools

Given the difficulty in quantifying "reproductive potential," a variety of surrogate markers has been used to measure ovarian reserve. These include laboratory values such

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Table 1

Definitions of ovarian reserve in the literature

Study	Year	Definition	Common definition
Ledger [4]	2014	Number of oocytes with the potential to ovulate	Reproductive potential of the patient at a certain point in time
Ding et al [5]	2015	Number and quality of the remaining primordial follicles at any given time	
Raffi et al [6]	2015	Total ovarian follicle pool = resting (primordial) + growing follicles	
Chang et al [7]	2010	Number and quality of follicles left in the ovary at any given time	

as anti-Müllerian hormone (AMH) and follicle-stimulating hormone (FSH); ultrasound findings such as antral follicle count (AFC), ovarian flow, and ovarian volume; and clinical variables such as response to ovarian stimulation and pregnancy rate. AMH has gained popularity because of its reproducibility and stability throughout the menstrual cycle. AMH and AFC have been used as the best predictors for ovarian response before proceeding with ovarian stimulation in assisted reproductive technologies (ARTs) [8].

Anti-Müllerian Hormone

AMH is produced by granulosa cells in active follicles (primary, preantral and small antral follicles) but not by quiescent primordial follicles. AMH regulates folliculogenesis by controlling the number of primordial follicles that start the maturation process and thus prevent depletion of the resting follicles (Fig) [8,12].

Several characteristics of AMH make it a useful marker of ovarian reserve for both clinical and research purposes. It has been shown to be a sensitive and specific marker of ovarian reserve, and it is the first marker to change with advancing age preceding changes in AFC, FSH, or estradiol. It is a stable marker and, unlike FSH, can be measured at any time during the menstrual cycle. It also has good interoperator consistency and is relatively low cost [8]. In addition, AMH level has been shown to be a reliable predictor of several ART outcomes, such as number and quality of oocytes retrieved [13,14]. As a result, many in vitro fertilization (IVF) programs obtain AMH measurements to identify appropriate candidates for ovarian stimulation and to select the appropriate protocol before proceeding with treatment [15]. Table 2 describes AMH values corresponding to ovarian reserve [16,17].

Some authors have disputed the widespread use of AMH in the evaluation of ovarian reserve. In 2014, Muzii et al challenged the precision of AMH for assessment of ovarian reserve in ovaries that have undergone surgery because AMH is a systemic marker [18]. Ledger [5] expressed concern regarding the ability to interpret changes in AMH levels given the variability in AMH measurements when measured by different kits. Raffi et al [7] showed a greater decline in postoperative AMH when a kit produced by Diagnostics Systems Ltd. was used compared with AMH changes measured by Immunotech Ltd. kits (46% vs 27%). The 2 tests were eventually merged by Beckman Coulter Inc.; however, given ongoing concerns about the accuracy of the AMH test, a new test (Gen II ELISA) was introduced in 2013. This new test produced results up to 40% higher than the original tests [12]. It is important to consider this variation when evaluating prior studies, because AMH changes are being compared between studies that used different AMH kits. Three new tests are now available. Studies show good correlation among these 3 tests and with the Gen II ELISA assay [19], helping to eliminate prior concerns regarding the ability to compare AMH results if different kits were used.

Antral Follicle Count

AFC is the sum of small antral follicles (sizing, 2–10 mm) visible on transvaginal ultrasound on days 2 to 4 of the menstrual cycle [13]. The role of AFC has been well established as a predictor of ART outcomes [20].

Muzii et al recommends AFC to assess changes in ovarian reserve after cystectomy because it correlates directly with ovarian reserve in a single ovary [21]. They argued this would help isolate the effect of the surgical procedure on

Fig

Follicular development.