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Incidence, time trends, laterality, indications, and pathological findings of unilateral oophorectomy before menopause

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Abstract

Objective—Unilateral oophorectomy (UO) is common, yet it remains understudied. We investigated trends in incidence rates, indications, and pathological differences in the right and left ovary in women younger than 50 years.

Methods—The Rochester Epidemiology Project medical records-linkage system was used to identify all women who underwent UO between 1950 and 2007 in Olmsted County, Minnesota (n=1,838). We studied incidence rates, indications, and pathology of UO by laterality and investigated trends over time.

Results—Pooling all oophorectomies over a 58-year period, the incidence of UO was higher than the incidence of bilateral oophorectomy through age 39 years; however, bilateral oophorectomy surpassed UO thereafter. The incidence of UO increased from 1950 to 1974 but decreased thereafter, and was surpassed by the rate of bilateral oophorectomy after 1979. Prior to 1985, left ovaries were removed more frequently than right ovaries both with and without a medical indication for UO. Ovaries removed with a medical indication showed pathologic

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differences between right and left, with endometriosis more common on the left. Ovaries removed without a medical indication did not differ in pathology by side.

Conclusion—There have been major trends in UO over 6 decades. Medically-indicated UO has been more common on the left due, in part, to the higher prevalence of endometriosis. However, UO without a medical indication has also been more common on the left as a result of surgical preferences and traditions. The long-term consequences of right or left UO on timing of menopause, morbidity, and mortality need further study.

Keywords

Unilateral oophorectomy; Laterality; Pathology; Incidence; Epidemiology; Time trends

Trends in the incidence of bilateral oophorectomy have been previously reported and have fluctuated over the past five decades.^{1–3} The frequency of bilateral oophorectomy reflects, in part, the prevailing view of the risk versus benefit of removing normal ovaries for the prevention of later disease. Prophylactic bilateral oophorectomy, where surgical intervention is done to decrease the risk of ovarian and breast cancer, was more common until recently. Since the mid-2000s, several studies have reported higher overall mortality in women who underwent bilateral oophorectomy compared to referent women, despite the decreased risk of ovarian and breast cancer.^{4–6} Increased risks of cardiovascular disease, hip fracture, neurological diseases, and other chronic diseases seem to offset the decreased risk of ovarian and breast cancer, especially when the ovaries are removed before a woman reaches age 50 years.^{4, 7–9}

In contrast, there has been little study of unilateral oophorectomy (UO), probably because the prevailing view has been that one ovary is sufficient for normal endocrine and reproductive function, and that the ovaries are interchangeable. However, the effects of UO on the timing of menopause and on subsequent morbidity and mortality remain uncertain.^{10–12} We conducted a formal literature review and confirmed that laterality and pathology in unilateral oophorectomy have not been studied extensively (PubMed search for articles in English). Therefore, we studied all women with unilateral oophorectomies performed over a 58-year period in Olmsted County, Minnesota to investigate the incidence, time trends, indications, and pathology by laterality of oophorectomy. In particular, we investigated the pathological differences in right and left UO contrasting women with and without a medical indication. We hope that this descriptive study will prompt further investigations of UO and of differences between the right and left ovary.

Materials and Methods

Study population

This study was based on a previously described cohort of women who underwent UO from 1950 to 1987,^{1, 6, 13–14} and on a new cohort of UO performed from 1988 to 2007 that has not been previously reported. For the 1950–1987 cohort, all analyses and results were novel because of the focus on laterality, indication, and pathologic findings in UO. Thus, in total, we studied the geographically defined population of Olmsted County, Minnesota, USA from January 1, 1950 through December 31, 2007 (58 years). The county population was

predominately urban, with more than 70% of county residents living in the city of Rochester. The remainder of the county was suburban or rural, consisting of several smaller communities. Extensive details about the Olmsted County population were reported elsewhere.^{15–18}

Collection of clinical data

Women who underwent UO before 50 years of age were identified using the Rochester Epidemiology Project, a unique population-based medical records-linkage system.^{15–18} Residents of Olmsted County are served by a limited number of healthcare facilities, and all these facilities participate in the medical records-linkage system. The nearest metropolitan area is 90 miles away and the population is stable. A tertiary care center is among the healthcare facilities (Mayo Clinic), so that referrals out of the county are limited.^{15–18}

The methods used to identify women who underwent UO have been described previously.^{1, 13} Briefly, the electronic indexes of the system were searched for the surgical procedure codes for UO. We included all women undergoing a first UO during the study period, defined as complete removal of one ovary. Women who underwent a first unilateral oophorectomy before the study period, and a second UO during the study period were excluded from incidence calculations (considered equivalent to bilateral oophorectomy). Patient's date of birth, date of surgery, and the co-occurrence of hysterectomy at the time of oophorectomy were recorded.

A nurse or a physician abstractor reviewed complete inpatient and outpatient records, including the surgeon's narrative report of the operation, to confirm the type of surgery and to define the primary ovarian indication for the surgery. Indications included cancer or cancer-related diagnoses, benign condition, torsion, and inflammatory disease or oophoritis. A woman was considered to have no medical indication if the oophorectomy was performed in the course of another surgery but without any ovarian condition, or was defined as elective by the surgeon. We report the results separately for women who had a UO with and without a medical indication because laterality and pathology were hypothesized to differ by indication. Because UO was commonly performed at the time of hysterectomy, the incidence rates and indications are also shown separately for the subgroup of women who underwent UO with concurrent hysterectomy (or had hysterectomy before the UO).

Collection of pathology data

The pathology report was based on the evaluation of frozen sections of the ovary at the time of the surgery and on the subsequent confirmation on permanent sections.¹³ The medical records abstractor categorized pathology as primary ovarian cancer or metastatic cancer, endometriosis, cyst, benign tumor, oophoritis or inflammatory process, atrophy, or other lesion (including ectopic pregnancy, adhesions, abscess, and infarction). Ovaries that had no pathologic diagnoses were labeled as "apparently normal."

Statistical Analysis

Incidence rates were calculated by dividing the number of women who underwent a first UO by the number of women at risk in the Olmsted County population and then multiplying by

100,000. Population denominators were derived from the US Decennial Censuses for the years 1950 to 2010, and intercensal year population denominators were linearly interpolated. Where appropriate, overall incidence rates were age-adjusted to the total US female population from the 2000 Census. The distributions of indications and pathologies for the left and the right ovary were compared using chi-square tests. All analyses were conducted using SAS v. 9.2 (SAS, Cary, NC), and tests of significance were undertaken at the two-tailed alpha level of 0.05. The institutional review boards at Mayo Clinic and Olmsted Medical Centers approved the study.

Results

Age patterns and time trends

Between 1950 and 2007, 1,838 women younger than age 50 years underwent UO while living in Olmsted County, MN. About 60% of the UOs occurred at the time of hysterectomy. Age-specific incidence rates are provided in Table 1 for all women who underwent UO and separately for the subgroup of women who underwent UO with hysterectomy over six time periods (five decades and eight additional years). Pooling all oophorectomies over the study period of 58 years, UO was more common than bilateral oophorectomy through age 39 years, at which time the incidence of bilateral oophorectomy surpassed that of UO (Figure 1, panel A). The left ovary was removed more frequently than the right ovary for all ages, but particularly for women between the ages of 35 to 49 years (overall 55.3% left vs. 44.7% right; $P < 0.0001$; Figure 1, panel A).

Temporal trends of age-standardized incidence rates showed that a decrease in UO rates coincided with an increase in bilateral oophorectomy rates (Figure 1, panel B). The incidence rates for UO increased from 1950 to 1974, but decreased after 1974. By contrast, bilateral oophorectomy was performed less frequently than UO from 1950 through 1969, was performed as frequently as UO from 1970 through 1984, and then surpassed UO starting in 1985 (Figure 1, panel B).¹ Temporal trends also demonstrated a difference in laterality of UO. Age-standardized incidence rates of left UO were higher than of right UO from 1950 through 1984 (79.9 left vs. 54.9 right per 100,000 person-years), but were similar in the most recent 23 years (34.5 left vs. 34.6 right per 100,000 person-years; 1985–2007).

We divided the cohort into two age groups to approximate the premenopausal (0–39 years) and perimenopausal (40–49 years) periods. Left UO was performed more commonly than right UO in women of age 0–39 years until 1979 (45.4 left vs. 34.4 right per 100,000 person-years; Figure 2, panel A) and for women aged 40–49 years until 1989 (170.2 left vs. 102.3 right per 100,000 person-years; Figure 2, panel D).

UO with or without hysterectomy

We investigated time trends for women who underwent UO with and without concurrent hysterectomy. There was no clear trend among women younger than 40 years (Figure 3, panel A). By contrast, among women 40–49 years of age, UO was more commonly performed concurrently with hysterectomy through 1989 (Figure 3, panel B).

UO with medical indication

Figure 2 also shows the trends over time in laterality for the women who had a UO with a medical indication, divided into two age groups (panels B and E). In both age groups, the left ovary was removed more commonly than the right ovary through 1979. The most common indication for UO was a benign condition of the ovary for all women and for women with concurrent hysterectomy (Table 2). Among women with concurrent hysterectomy, the right ovary was removed for the indication of a benign condition more frequently than the left ovary (69.6% right vs. 63.3% left, $P = 0.03$, Table 2). All medical indications were similar in the right and the left ovary, except “other” medical indications which were more common in the right ovary (3.0% right vs. 1.5% left; $P = 0.02$).

UO without medical indication

Women who underwent UO without a medical indication were the second largest group by indication in the overall incident series (20.2%) and among women with concurrent hysterectomy (31.8%; Table 2). The left ovary was removed more frequently without a medical indication than the right ovary in both the overall group (22.8% left vs. 17.0% right, $P = 0.002$; Table 2) and among women with concurrent hysterectomy (34.8% left vs. 27.8% right; $P = 0.01$). In women of age 0–39 years without a medical indication, the laterality differences were small throughout the study period (Figure 2, panel C). By contrast, in women aged 40–49 years, the left ovary was removed more commonly than the right through 1989 (Figure 2, panel F).

Pathology of UO

Table 3 shows the pathology found in the removed ovary over the entire study period by laterality. In the overall group, cysts were the most common pathologic finding and had similar frequency on both sides (29.2% left vs. 29.4% right; $P = 0.92$; Table 3). Apparently normal ovaries were the second most common pathologic finding overall and occurred similarly in the right and left ovary (19.4% left vs. 19.5% right; $P = 0.97$). By contrast, endometriosis occurred more frequently in the left ovary than in the right ovary (19.0% left vs. 13.4% right; $P = 0.001$). Although not statistically significant, primary ovarian cancer occurred more frequently in the right than in the left ovary (1.5% right vs. 0.7% left, $P = 0.10$). Other pathology, such as ectopic pregnancy, was more common in the right than left ovary (7.1% right vs. 4.4% left, $P = 0.01$).

Table 3 also shows the pathology found in the ovary removed from women with or without a medical indication. The pathology differed by laterality among women with a medical indication for UO. Endometriosis was more common in the left ovary (23.9% left vs. 15.8% right, $P = 0.0001$). “Other” pathologies were more common in the right ovary (7.8% right vs. 4.7% left, $P = 0.02$). By contrast, most ovaries removed without a medical indication were apparently normal on pathology (52.2% left vs. 55.7% right, $P = 0.51$), and the pathology did not differ significantly by side (Table 3).

Indication and resultant pathology were consistent. Of the 1,352 women with an indication of benign condition (Table 2), 1,197 (88.5%) had pathology consistent with a benign process (e.g., endometriosis or benign tumor). Among the remaining 155 women (11.5%), 137 had

normal ovaries, 13 had ovarian cancer, and 5 had unknown pathology. Of the 12 women with an indication of primary or metastatic cancer, 8 (66.7%) were confirmed by pathology.

Discussion

Major findings

Secular trends in the incidence of UO are influenced by trends in the incidence of bilateral oophorectomy,¹ which in turn are determined by evolving evidence and beliefs about the risk-to-benefit balance between conserving the ovaries to reduce menopausal symptoms and sequelae^{4–6} and removing the ovaries to decrease the risk of ovarian or breast cancer and the risk of reoperation.^{8, 9} Many studies have influenced this balance over time, leading to major trends in gynecological practices.^{2, 19–20} Our study showed a link between the trends in bilateral oophorectomy and the trends in UO rates over the most recent 58-year period in a well-defined US population.

UO without a medical indication has been influenced by surgical preferences and traditions. Between 1950 and 1985, preservation of ovarian function during concurrent hysterectomy was the tradition, so there was an attempt to save at least one ovary.^{21–22} In our study, the incidence of left oophorectomy was higher than the incidence of right oophorectomy until approximately 1985. In reviewing medical records, we learned that it was customary to remove one ovary to reduce the risk of future reoperation. The left ovary was preferentially removed if both ovaries appeared normal, because of its proximity with the sigmoid colon.²³ The decline in this practice over time coincides with the increased use of ultrasound for diagnostic purposes.²⁴

In the women who underwent UO for a medical indication, the pathology differed between the left and right side. We confirmed the findings from previous studies that endometriosis is more common in the left than in the right ovary.^{25–26} Two theories behind the formation of endometriosis may explain this laterality. First, the retrograde menstruation theory postulates that endometrium is expelled from the fallopian tubes into the peritoneum. Elimination of this endometrial tissue may be less efficient on the left side because of the anatomic proximity with the colon²⁷ or the decreased flow of peritoneal fluid on the left.²⁸ Therefore, tissue deposited on the left ovary would have greater opportunity to adhere and implant. The second theory is based on the functional difference between ovaries. The right ovary ovulates more frequently than the left and therefore, has higher localized progesterone production which suppresses endometriosis.^{29–31}

Strengths

Although the initial time segment of our study was based on previously collected data (38 years), our focus on laterality, indication, and pathologic findings in UO was novel and prompted a complete re-analysis of the data. We combined the older data and the new data from the most recent 20 years to provide a long-term perspective on surgical practices (58 years). The strengths of our study include documentation of the laterality of oophorectomy and of whether a contralateral oophorectomy had previously been done in the medical records, avoiding recall bias and inaccuracy of reporting. Additionally, availability of

incidence rates for bilateral oophorectomy in the same population from a previous study allowed the comparison of rates for both surgeries over time.^{1, 13}

Limitations

A first limitation of this study is the local nature of UO practices. Surgical practices typical of the Mayo Clinic and other care providers in Olmsted County may not reflect national trends. A literature review failed to reveal national or regional guidelines for UO in the first 4 decades of our study. Thus, local surgical preferences and traditions may have influenced the decision to remove the right or the left ovary without a medical indication. Second, we may have undercounted women who resided in Olmsted County but underwent a unilateral oophorectomy at a medical facility not included in the REP, or women who were incorrectly coded in their medical records or in the electronic indexes of the REP system. Based on our experience in manually abstracting medical records,^{32–33} these two events are rare and have not changed over time. Finally, our population includes primarily white women of northern and central European descent, thus, our findings may not be generalizable to other populations or ethnic groups. However, the population is similar to a large segment of the US population.¹⁶

CONCLUSIONS

UO is thought to be safer than bilateral oophorectomy in premenopausal women because of the assumption that the remaining ovary continues to provide adequate amounts of circulating hormones. However, several studies of UO have demonstrated diminished function of the contralateral ovary following surgery either with or without concurrent hysterectomy.^{10–12} The effect of the removal of only one ovary on the timing of menopause and on subsequent mortality is understudied. Further investigation of outcomes associated with UO will provide better practice guidelines, especially for those women who undergo oophorectomy without a medical indication.

One study showed no difference in the risk of myocardial infarction outcomes after UO,³⁴ and a study from this Olmsted County cohort showed a mild reduction of subsequent cardiovascular mortality.¹⁴ However, UO in women younger than 42 years was associated with increased risk of parkinsonism and of cognitive impairment or dementia in this Olmsted County population.^{32–33} Future research should confirm these initial associations of UO with cardiovascular disease and neurologic disease, and should focus on laterality. We may be overlooking the importance of anatomical and functional differences in the right and left ovaries. Viewing the ovaries as interchangeable and symmetrical may lead to surgical practices that have detrimental long-term effects.

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Figure 1.

Incidence rates of unilateral oophorectomy and bilateral oophorectomy in Olmsted County, Minnesota, from 1950 to 2007. Incidence rates are shown across age groups (panel A; average age-specific incidence rates over a 58-year period) and across calendar year groups (panel B; calendar year-specific incidence rates). Unilateral oophorectomy incidence rates are also shown separately for the left and the right ovary. Incidence rates across calendar year are age-standardized to the total population from the 2000 US Census. The data on the incidence of bilateral oophorectomy were derived from a previous study in Olmsted County, Minnesota¹. Note that the y-axis scale differs between panel A and panel B.

Figure 2.

Time trends in the incidence of unilateral oophorectomy by age group and laterality in Olmsted County, Minnesota, from 1950 to 2007. Panels A and D show trends for all unilateral oophorectomies combined. Panels B and E show the incidence of unilateral oophorectomy with an ovarian medical indication, and panels C and F show the incidence of unilateral oophorectomy without a specified ovarian medical indication. Incidence is shown for women younger than 40 years (top panels A, B, and C) and for women age 40–49 years (bottom panels D, E, and F).

Figure 3.

Time trends in the incidence of unilateral oophorectomy by age group and hysterectomy status in Olmsted County, Minnesota, from 1950 to 2007. Incidence is shown for women younger than 40 years (panel A) and women age 40–49 years (panel B).

Table 1

Age-specific incidence rates of right or left unilateral oophorectomy in Olmsted County, Minnesota from 1950 to 2007*

Age group	Person years	All unilateral oophorectomies			Unilateral oophorectomies with hysterectomy [†]		
		Left	Right	Any	Left	Right	Any
		Rate (n) [‡]	Rate (n) [‡]	Rate (n) [‡]	Rate (n) [‡]	Rate (n) [‡]	Rate (n) [‡]
Years 1950 to 1959							
0–19	105,325	3.8 (4)	0.9 (1)	4.7 (5)	0.0 (0)	0.0 (0)	0.0 (0)
20–24	26,597	18.8 (5)	18.8 (5)	37.6 (10)	0.0 (0)	0.0 (0)	0.0 (0)
25–29	22,034	54.5 (12)	31.8 (7)	86.2 (19)	13.6 (3)	4.5 (1)	18.2 (4)
30–34	20,267	93.7 (19)	29.6 (6)	123.4 (25)	39.5 (8)	4.9 (1)	44.4 (9)
35–39	18,782	122.5 (23)	101.2 (19)	223.6 (42)	79.9 (15)	47.9 (9)	127.8 (24)
40–44	17,126	163.5 (28)	99.3 (17)	262.8 (45)	146.0 (25)	87.6 (15)	233.6 (40)
45–49	16,535	199.6 (33)	108.9 (18)	308.4 (51)	169.3 (28)	84.7 (14)	254.0 (42)
All ages 0–49	226,666	54.7 (124)	32.2 (73)	86.9 (197)	34.9 (79)	17.6 (40)	52.5 (119)
Years 1960 to 1969							
0–19	151,258	4.0 (6)	4.6 (7)	8.6 (13)	0.0 (0)	0.0 (0)	0.0 (0)
20–24	35,804	55.9 (20)	36.3 (13)	92.2 (33)	2.8 (1)	2.8 (1)	5.6 (2)
25–29	29,694	67.4 (20)	47.1 (14)	114.5 (34)	33.7 (10)	6.7 (2)	40.4 (12)
30–34	25,811	100.7 (26)	96.9 (25)	197.6 (51)	62.0 (16)	54.2 (14)	116.2 (30)
35–39	21,495	167.5 (36)	102.3 (22)	269.8 (58)	121.0 (26)	74.4 (16)	195.4 (42)
40–44	19,862	226.6 (45)	151.0 (30)	377.6 (75)	206.4 (41)	135.9 (27)	342.4 (68)
45–49	19,066	178.3 (34)	94.4 (18)	272.7 (52)	146.9 (28)	78.7 (15)	225.5 (43)
All ages 0–49	302,990	61.7 (187)	42.6 (129)	104.3 (316)	40.3 (122)	24.8 (75)	65.0 (197)
Years 1970 to 1979							
0–19	163,452	6.7 (11)	5.5 (9)	12.2 (20)	0.0 (0)	0.6 (1)	0.6 (1)
20–24	48,309	49.7 (24)	41.4 (20)	91.1 (44)	8.3 (4)	6.2 (3)	14.5 (7)
25–29	41,277	75.1 (31)	70.3 (29)	145.4 (60)	41.2 (17)	41.2 (17)	82.4 (34)
30–34	34,177	152.1 (52)	117.0 (40)	269.2 (92)	120.0 (41)	81.9 (28)	201.9 (69)
35–39	27,037	225.6 (61)	177.5 (48)	403.2 (109)	207.1 (56)	159.0 (43)	366.2 (99)
40–44	24,050	207.9 (50)	120.6 (29)	328.5 (79)	187.1 (45)	104.0 (25)	291.1 (70)
45–49	20,782	115.5 (24)	105.9 (22)	221.3 (46)	115.5 (24)	91.4 (19)	206.9 (43)

Age group	Person years	All unilateral oophorectomies				Unilateral oophorectomies with hysterectomy [‡]			
		Left	Right	Rate (n) [†]	Rate (n) [†]	Any	Left	Right	Any
All ages 0–49	359,084	70.5 (253)	54.9 (197)	125.3 (450)	52.1 (187)	37.9 (136)	90.0 (323)		
Years 1980 to 1989									
0–19	155,533	4.5 (7)	7.1 (11)	11.6 (18)	0.0 (0)	1.3 (2)	1.3 (2)		
20–24	46,629	23.6 (11)	15.0 (7)	38.6 (18)	2.1 (1)	2.1 (1)	4.3 (2)		
25–29	49,385	46.6 (23)	62.8 (31)	109.3 (54)	10.1 (5)	24.3 (12)	34.4 (17)		
30–34	46,703	68.5 (32)	85.6 (40)	154.2 (72)	34.3 (16)	53.5 (25)	87.8 (41)		
35–39	38,045	110.4 (42)	89.4 (34)	199.8 (76)	97.3 (37)	63.1 (24)	160.3 (61)		
40–44	31,829	172.8 (55)	103.7 (33)	276.5 (88)	150.8 (48)	100.5 (32)	251.3 (80)		
45–49	25,802	112.4 (29)	46.5 (12)	158.9 (41)	96.9 (25)	38.8 (10)	135.6 (35)		
All ages 0–49	393,926	50.5 (199)	42.6 (168)	93.2 (367)	33.5 (132)	26.9 (106)	60.4 (238)		
Years 1990 to 1999									
0–19	167,513	2.4 (4)	2.4 (4)	4.8 (8)	0.0 (0)	0.0 (0)	0.0 (0)		
20–24	37,116	8.1 (3)	24.2 (9)	32.3 (12)	2.7 (1)	2.7 (1)	5.4 (2)		
25–29	49,238	10.2 (5)	24.4 (12)	34.5 (17)	2.0 (1)	8.1 (4)	10.2 (5)		
30–34	51,279	56.6 (29)	41.0 (21)	97.5 (50)	13.7 (7)	19.5 (10)	33.2 (17)		
35–39	49,453	84.9 (42)	60.7 (30)	145.6 (72)	54.6 (27)	30.3 (15)	84.9 (42)		
40–44	46,002	63.0 (29)	73.9 (34)	137.0 (63)	43.5 (20)	39.1 (18)	82.6 (38)		
45–49	37,975	34.2 (13)	34.2 (13)	68.5 (26)	23.7 (9)	18.4 (7)	42.1 (16)		
All ages 0–49	438,576	28.5 (125)	28.0 (123)	56.5 (248)	14.8 (65)	12.5 (55)	27.4 (120)		
Years 2000 to 2007									
0–19	146,796	1.4 (2)	2.0 (3)	3.4 (5)	0.0 (0)	0.0 (0)	0.0 (0)		
20–24	31,582	22.2 (7)	12.7 (4)	34.8 (11)	0.0 (0)	0.0 (0)	0.0 (0)		
25–29	39,778	45.3 (18)	27.7 (11)	72.9 (29)	10.1 (4)	5.0 (2)	15.1 (6)		
30–34	38,271	44.4 (17)	65.3 (25)	109.7 (42)	15.7 (6)	20.9 (8)	36.6 (14)		
35–39	41,090	65.7 (27)	77.9 (32)	143.6 (59)	26.8 (11)	38.9 (16)	65.7 (27)		
40–44	41,875	78.8 (33)	81.2 (34)	160.0 (67)	43.0 (18)	35.8 (15)	78.8 (33)		
45–49	39,565	60.7 (24)	58.1 (23)	118.8 (47)	22.7 (9)	27.8 (11)	50.5 (20)		
All ages 0–49	378,957	33.8 (128)	34.8 (132)	68.6 (260)	12.7 (48)	13.7 (52)	26.4 (100)		

* Per 100,000 person-years

[†]Incidence rates computed by dividing the number of women who underwent unilateral oophorectomy (n) by the person-years at risk and expressed per 100,000 person-years.

[‡]Includes women who underwent hysterectomy concurrently with the unilateral oophorectomy and women who had undergone hysterectomy before the unilateral oophorectomy.

Table 2

Indications for unilateral oophorectomy by laterality and hysterectomy status in Olmsted County, Minnesota from 1950 to 2007

Indication	Laterality*					
	Left			Right		
	n	%		n	%	Total
All unilateral oophorectomies						
Primary Cancer	2	0.2	5	0.6	.15	7 0.4
Metastatic Cancer	3	0.3	2	0.2	.84	5 0.3
Benign Condition	737	72.5	615	74.8	.27	1,352 73.6
Torsion	27	2.7	35	4.3	.06	62 3.4
No medical indication	232	22.8	140	17.0	.002	372 20.2
Other	15	1.5	25	3.0	.02	40 2.2
Total [†]	1,016	55.3	822	44.7	<.0001	1,838 100.0
Unilateral oophorectomies with hysterectomy [‡]						
Primary Cancer	2	0.3	0	0.0	.23	2 0.2
Metastatic Cancer	2	0.3	2	0.4	.75	4 0.4
Benign Condition	401	63.3	323	69.6	.03	724 66.0
Torsion	4	0.6	4	0.9	.66	8 0.7
No medical indication	220	34.8	129	27.8	.01	349 31.8
Other	4	0.6	6	1.3	.26	10 0.9
Total [†]	633	57.7	464	42.3	<.0001	1,097 100.0

* The overall distribution of indications for oophorectomy differed between the left and right side (homogeneity chi-square test $P = 0.002$). The distribution of indications did not differ when restricted to oophorectomies with hysterectomy (homogeneity chi-square test $P = 0.12$).

[†] The percentages in this row refer to the total number of women with unilateral oophorectomy ($n = 1,838$ women overall and 1,097 women with hysterectomy).

[‡] Includes women who underwent hysterectomy concurrently with unilateral oophorectomy and women who had undergone hysterectomy before unilateral oophorectomy.

Pathology in removed ovary separate by indication for surgery and laterality in Olmsted County, Minnesota from 1950 to 2007

Table 3

Pathology of ovary	All unilateral oophorectomies*					With medical indication†					Without medical indication‡				
	Left ovary		Right ovary		P	Left ovary		Right ovary		P	Left ovary		Right ovary		P
	n	%	n	%		n	%	n	%		n	%	n	%	
Primary cancer	7	0.7	12	1.5	.10	7	0.9	12	1.8	.14	0	0.0	0	0.0	§
Metastatic cancer	2	0.2	1	0.1	.69	2	0.3	0	0.0	.19	0	0.0	1	0.7	.20
Benign tumor	176	17.3	162	19.7	.19	171	21.8	159	23.3	.49	5	2.2	3	2.1	.99
Endometriosis	193	19.0	110	13.4	.001	187	23.9	108	15.8	.0001	6	2.6	2	1.4	.46
Oophoritis	55	5.4	31	3.8	.10	34	4.3	18	2.6	.08	21	9.1	13	9.3	.94
Cyst	297	29.2	242	29.4	.92	233	29.7	208	30.5	.75	64	27.6	34	24.3	.48
Inflammatory process	37	3.6	37	4.5	.35	35	4.5	36	5.3	.47	2	0.9	1	0.7	.88
Atrophy	3	0.3	5	0.6	.31	0	0.0	3	0.4	.06	3	1.3	2	1.4	.91
Other pathology	45	4.4	58	7.1	.01	37	4.7	53	7.8	.02	8	3.4	5	3.6	.95
Apparently normal	197	19.4	160	19.5	.97	76	9.7	82	12.0	.15	121	52.2	78	55.7	.51
Unknown	4	0.4	4	0.5	.76	2	0.3	3	0.4	.55	2	0.9	1	0.7	.88
All pathologies¶	1,016	55.3	822	44.7	<.0001	784	53.5	682	46.5	.008	232	62.4	140	37.6	<.0001

* The overall distribution of pathologies in ovaries removed for any reason differed between the left and right side (homogeneity chi-square test $P = 0.01$).

† A medical indication for removal of one ovary was given. These included primary ovarian cancer (7), metastatic ovarian cancer (5), benign medical conditions (1352), torsion (62), and other conditions (40). The overall distribution of pathologies in ovaries removed for a medical reason differed between the left and right side (homogeneity chi-square test $P = 0.001$).

‡ No medical indication was given for removal of the ovary, but the ovary was taken incidentally at the time of hysterectomy (349) or at the time of another surgery (23). The overall distribution of pathologies in ovaries removed without a medical reason did not differ between the left and right side (homogeneity chi-square test $P = 0.97$).

§ The p value was not reported because both frequencies were 0.0%.

¶ The percentages in this row refer to the total number of women with medical indication, without medical indication, or in the combined group. Left unilateral oophorectomies were performed more frequently without a medical indication than with a medical indication (62.4% vs. 53.5%; chi-square test $P = 0.002$).