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INCIDENCE OF SARCOMA IN PATIENTS UNDERGOING HYSTERECTOMY FOR BENIGN INDICATIONS: A POPULATION-BASED STUDY

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Abstract

Background—Minimally invasive hysterectomy may require the use of morcellation to remove the uterus. In the presence of unexpected sarcoma, morcellation risks disseminating malignant cells and worsening survival outcomes. As a consequence, in 2014 the US Food and Drug Administration (FDA) issued a black box warning against the use of power morcellator for the treatment of uterine fibroids. However, the proportion of unexpected sarcoma at the time of hysterectomy for presumed benign indication remains unclear.

Objective—To estimate the incidence of sarcoma among women undergoing hysterectomy for benign indication in Olmsted County, Minnesota, between 1999 and 2013.

Methods—We conducted a population-based study including all hysterectomies performed for benign indication in Olmsted County women between 1/1/1999 and 12/31/2013. Cases were identified using the medical records-linkage system of the Rochester Epidemiology Project, and data were abstracted by a gynecologist who reviewed the complete medical records of each

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woman who underwent hysterectomy. An expert pathologist reviewed the pathologic slides of each sarcoma to ensure the accuracy of the diagnosis. Incidences of sarcoma (overall and by type of sarcoma) were estimated both overall and stratified by menopausal status, indication for surgery, and uterine weight as a rate per 100 persons.

Results—A total of 4,232 hysterectomies were performed during the study period. Among them, we identified 16 sarcomas, of which 11 (69%) were suspected pre-operatively and 5 (31%) were unexpected. Of the total number of hysterectomy, 3,759 (88.8%) were performed for benign indication. Among those, the incidence of unexpected sarcoma was 0.13% (5/3,759 [95% CI, 0.04 to 0.31%]). Uterine fibroids comprised 27.3% (n=1,025) of all hysterectomies for benign indication and was the indication most commonly associated with diagnosis of unexpected sarcoma. The incidence of unexpected sarcoma among surgeries for uterine fibroids was 0.35% (3/851) for premenopausal women and 0.57% (1/174) for peri/postmenopausal, and all 4 unexpected sarcomas were leiomyosarcoma. The incidence of unexpected sarcoma progressively increased with higher uterine weight with an incidence of 0.03% (1/2,993) among women with a uterine weight <250 grams versus 15.4% (2/13) with a uterine weight >=2,000 grams.

Conclusions—Unexpected uterine sarcoma was low in all women undergoing hysterectomy for benign indication (0.13% or 1 in 752 surgeries), while increased in women with uterine fibroids (0.39% or 1 in 256 surgeries). Peri-post-menopausal women, women with large uteri, and age ≥45 were risk factors for sarcoma.

CONDENSATION:

In patients who undergo hysterectomy for uterine fibroids, the incidence of uterine sarcoma is 0.6%; age ≥45 and uterine weight are associated with risk of uterine sarcoma.

Keywords

hysterectomy; uterine fibroids; uterine sarcoma; morcellation; Olmsted County

Introduction

Hysterectomy is the most common major gynecologic surgery performed in the United States, with over 600,000 hysterectomies performed each year for benign indications[1,2]. Among those, uterine fibroids represent the most frequent indication, accounting for approximately 30–40% of all benign hysterectomies[1]. By contrast, uterine sarcomas are rare and aggressive tumors, accounting for approximately 1% of the female tract malignancies[3], and with an incidence of 3–7 per 100,000 women[4]. During the last decades, the surgical approach to hysterectomy shifted from open laparotomy to minimally invasive (laparoscopic-assisted or robotic-assisted), which is preferred by most women because it is less invasive, associated with lower rate of complications, and has faster recovery[5,6]. Minimally invasive approach may require the use of morcellation to facilitate the extraction of the specimens from the vagina or through the small port incisions, especially in the presence of a large uterus with fibroids. This process of morcellation carries the risk of disseminating benign or malignant disease[7–10]. In the latter case, dissemination of malignant tissue would increase risk of recurrence and shorten survival[11].

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In the last four years, the use of morcellation has come under scrutiny because of a hysterectomy case where a leiomyosarcoma (LMS) presumed to be a benign fibroid was incidentally morcellated[12]. As a consequence, the FDA "warned against" the use of uterine power morcellation, issuing "contraindications" for its use in "peri- and post-menopausal" women, and in patients with "suspected or known malignancy"[13]. Also, the FDA reported a meta-analysis which estimated that the rates of unexpected sarcoma and LMS at the time of surgery for presumed benign fibroids were 1 in 352 surgeries (0.28%) and 1 in 498 surgeries (0.20%), respectively[14]. Several studies reported the incidence of unexpected sarcoma among women who underwent hysterectomy with an indication of uterine fibroids, ranging from 0.00–0.49%[15]. Given the varying incidence reported by those studies, we conducted a population-based study aimed to estimate the incidence of unexpected sarcoma (overall and by type of sarcoma) among women who underwent hysterectomy for benign indication. We also stratified the incidence of unexpected sarcoma by factors that may increase the risk of sarcomas, such as menopausal status, indication for surgery, and uterine weight.

Materials and Methods

We conducted a population-based study using the Rochester Epidemiology Project (REP), a unique medical records-linkage system established in 1966 and including the health records of virtually all residents of Olmsted County, Minnesota, regardless of insurance status[16,17]. The REP includes the health care information of a dynamic cohort of over 500,000 unique individuals who resided in Olmsted County from 1966 up to the present day[17]. Participants who do not provide permission to use their medical records for research are excluded from research studies (<3% of the overall population)[17]. The institutional review board (IRB) of both Mayo Clinic (#15–003573) and Olmsted Medical Center (032-omc-15) approved the present study.

Using the REP medical records-linkage system, a REP database specialist identified all hysterectomies performed among residents of Olmsted County from 1/1/1999 to 12/31/2013 using the International Classification of Diseases, Ninth Revision (ICD-9) procedures codes for hysterectomy. To confirm the hysterectomies and to obtain the clinical data, the complete medical records of each woman who underwent a hysterectomy was extensively reviewed by one of three gynecologists (F.M., J.C., L.T.) following a specifically designed abstracting form. Prior to review, all data abstractors agreed on definitions and interpretation of each collected variables, and conflicts were resolved by consensus. We defined peri-menopausal status as women who were still having bleeding (normal or abnormal menstrual pattern), but perimenopause was documented in the clinical notes. Uterine weight was obtained from the pathology report.

Uterine sarcomas were identified by reviewing the pathologic reports of all hysterectomies performed during the time period of the study. To ensure the accuracy of diagnosis of uterine sarcoma, an expert pathologist (Y.H.) re-reviewed the pathologic slides.

The incidence of sarcomas among all hysterectomies and the incidence of unexpected sarcomas among hysterectomies for benign conditions are expressed as a rate or percentage per 100 hysterectomies. Incidences of unexpected sarcomas (overall and by type of sarcoma)

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were stratified by age, menopausal status (pre- vs. peri-/post), indication for surgery (uterine fibroids vs. other benign indication), and uterine weight. A ninety-five percent confidence interval for each incidence rate was constructed using an exact test for a binominal parameter. Fisher's exact test was used to compare incidences between groups and Cochran-Armitage trend was used to test for a trend in incidences across ordinal age and uterine weight categories. All calculated p-values were two-sided and p-values less than 0.05 were considered statistically significant.

The study is reported following the Strengthening the Reporting of Observational studies in Epidemiology (STROBE statement) recommendations[18].

Results

A total of 4,232 women had hysterectomies performed in Olmsted County, MN during the time period of the study. Of these 4,232 women, 450 underwent hysterectomy where malignancy was found on pathologic examination and 23 had a pregnancy-related indication (Figure 1). The remaining 3,759 (88.8%) women had a hysterectomy for benign indications.

Among the total 4,232 women with hysterectomy, we identified 16 sarcomas (6 LMS, 4 low-grade endometrial stromal sarcoma (ESS), 3 high-grade ESS, 2 adenosarcoma, and 1 rhabdomyosarcoma), of which 11 were suspected preoperatively (5 pre-operative diagnosis of sarcoma, 6 pelvic mass of unknown origin) and 5 were unexpected. Patients' and tumor characteristics of 16 women with a sarcoma are reported in Table 1. All the 16 women were white. The mean (SD) age at diagnosis of sarcoma was 54.6 (10.6), and the median BMI was 32.5 (range 22.9–48.6). Preoperative imaging was obtained for 15 of the 16 women (94%): 8 had pelvic ultrasound, 4 computed tomography (CT) scan, 1 magnetic resonance imaging (MRI), 1 ultrasound and MRI, and 1 ultrasound and CT scan. Preoperative endometrial biopsy was performed in 4 of 16 patients. In total, preoperative diagnosis of sarcoma was found in 5 of 16 (31%) women, 1 with a CT guided biopsy on an asymptomatic women with incidental finding of uterine mass; 3 with a preoperative endometrial biopsy (1 LMS, 1 adenosarcoma, 1 rhabdomyosarcoma) on patients with postmenopausal bleeding; and 1 with a myomectomy on a women with presumed benign fibroids. The majority of the 16 women (81%) underwent an open abdominal approach, 1 was performed with laparoscopic-assisted vaginal approach, and the 2 remaining were performed vaginally (one of them was converted to robotic-assisted for staging after the intraoperative frozen section diagnosis of low-grade ESS). Of the 16 women with sarcoma, one with a low-grade ESS who had an intraoperative dilation and curettage of the uterus showing benign endometrium underwent manual morcellation. After 5 years of follow-up, she remained alive and disease-free.

Uterine weight was substantially larger for women with LMS and ESS. The median uterine weight for all 16 women was 745 grams (range 140–2641), with median of 1237 grams (range 585–2641) for women with LMS and median of 650 grams (range 140–1501) for women with ESS. The three women with adenosarcoma and rhabdomyosarcoma had uterine weights of 230 to 273.

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Among the 3,759 women with hysterectomy for a benign indication, the mean (SD) age at hysterectomy was 47.0 (11.1) years and the mean (SD) BMI was 29.0 (6.7) kg/m^2. The majority were white (n=3,513, 93.5%), followed by black (n=86, 2.3%) and Asian (n=61, 1.6%). The majorities were performed vaginally (2,280, 60.6%), followed by open abdominal approach (1,030, 27.4%), and minimally invasive approach (laparoscopic, laparoscopic-assisted vaginal approach, and robotic)(449, 11.9%). We identified 5 unexpected sarcomas among these 3,759 women, for an incidence of 0.13% (95% CI, 0.04 to 0.31%), including 4 LMS and 1 Low-Grade ESS (Table 2). Thus, in our cohort, the incidence of unexpected LMS was 0.11% (4/3759), whereas the incidence of low-grade ESS was 0.03% (1/3759). The incidence of unexpected sarcoma was not observed to be significantly higher in peri/post-menopausal women compared with pre-menopausal women (0.18% (2/1116) vs. 0.11% (3/2643), p=0.64).

After stratification by indication of surgery, the majority of unexpected sarcoma (4 out of 5, 80%) was diagnosed among the 1,025 patients who underwent hysterectomy for presumed benign fibroids, with an incidence of unexpected sarcoma of 0.39%. All 4 unexpected sarcoma diagnosed after surgery for benign fibroids were LMS. Also, in this subgroup of women with an indication of benign fibroids, the incidence of unexpected sarcoma was higher for peri-/postmenopausal compared to premenopausal women, although the difference was not statistically significant (0.57% (1/174) vs. 0.35% (3/851), p=0.53).

The age-stratified risk of unexpected sarcoma increased with increasing age (p=0.037, Table 3), with all age groups ≥ 45 years having higher risk than the overall risk of 0.13% or 1 in 752, except for the age group 65–74 years in which we did not identify any unexpected sarcoma. No unexpected sarcoma occurred in women under age 45 years.

Stratification by uterine weight showed that higher uterine weights were directly associated with an increase in the incidence of unexpected sarcoma (p<0.001, Table 4). The incidence of unexpected sarcoma was 0.03% (1/2,993) among women with a uterine weight <250 grams versus 14.3% (2/14) with a uterine weight ≥2,000 grams. Because the number of unexpected sarcomas was low, we performed a secondary analysis including all sarcomas (n=16) to estimate the incidence of sarcoma among all hysterectomies (n=4,232) stratified by uterine weight (Supplementary Table 1). Similar to the incidence of unexpected sarcoma, the incidence of any sarcoma progressively increased among all hysterectomy with increasing uterine weight from 0.09% among women with uterine weight < 250 grams to 0.7%, 1.4%, 6.3%, 11.1%, and 14.3%, among women with uterine weight 250–499, 500–999, 1000–1499, 1500–1999, and ≥2000 grams, respectively (p<0.001). Interestingly, all 6 LMS diagnosed in our cohort had uterine weight ≥500 grams, with 4 of them being ≥1000 grams.

Discussion

The present population-based study showed that the incidence of unexpected sarcomas in Olmsted County among all women undergoing hysterectomy for a benign indication is 0.13% or 1 in 752, which is between the incidences reported by two other large series (range of incidences of 1 in 454 and 1 in 1,124) in Michigan[19] and Texas[20], respectively. Among

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women undergoing hysterectomy for uterine fibroids, the incidence of unexpected sarcomas was 0.39% or 1 in 256, which is higher than anticipated based on prior reports[14,15]. One reason is that indication of "benign uterine fibroids" among post-menopausal women was reported in one of our cases. However, fibroids should not be symptomatic after menopause and thus, women presenting with symptoms should be suspected for possible cancer. If we consider only premenopausal women, our unexpected sarcoma incidence rates are 0.11% (or 1 in 881) and 0.35% (or 1 in 283) among women undergoing hysterectomy for any benign indication and for uterine fibroids, respectively. Importantly, no unexpected sarcoma occurred in women under age 45 years. Moreover, compared to other studies, the higher incidence of unexpected sarcomas among women with indication of uterine fibroids estimated in our study can be related to the lower proportion of hysterectomies for uterine fibroids which represent the denominator, accounting for only 27.3% of the total number of hysterectomies for benign indication. The lower proportion of hysterectomies for uterine fibroid in our study may be due to the large use in Olmsted County of non-surgical treatment of fibroids such as myomectomy, levonorgestrel-releasing intrauterine system, magnetic resonance-guided focused ultrasound, and uterine artery embolization. Of note, none of the women treated for uterine fibroid with conservative management in Olmsted County during the time period of the study were diagnosed with an unexpected sarcoma.

As expected, similar to Brohl et al[21] we demonstrated that the risk of unexpected sarcoma increases with age. In particular, the risk of unexpected sarcoma was higher for women ≥ 45 years old compared to women at younger age, with no unexpected sarcoma diagnosed among women <45 years of age. This finding is reassuring for the population of infertile women, in which conservative management of uterine fibroids can be offered at low risk of delaying a diagnosis of sarcoma.

A new finding is the impact of large uteri on sarcoma rates. To our knowledge, this is the first study estimating the incidence of sarcoma by uterine weight. In fact, although previous studies demonstrated that a sarcoma could be present also in the presence of small uteri[19,22], none of them reported the total number of uteri in each weight category, precluding any estimate of the incidence of sarcoma by uterine weight. From a practical standpoint, the preoperative prediction of uterine weight can be accurately performed either by a bimanual examination or by ultrasound using the prolate ellipsoid formula[23] or its simplified version[24] [weight (g) = uterine length × maximum width × anteroposterior diameter × 0.52].

Our study has several strengths. First, by using the medical records linkage system of the REP we were able to study a large population-based cohort that spanned 15 years. This allowed us also to avoid the referral bias of patients referred to a gynecologic oncologist for a suspected sarcoma. Second, since the REP includes all medical facilities in Olmsted County it is unlikely that a patient with sarcoma would have been missed while living in the county. Third, reviewing the pathologic slides to confirm the accuracy of the diagnosis of sarcoma allowed us to differentiate among types of uterine sarcoma and determine an accurate incidence of unexpected sarcoma that without confirmation would have been affected by risk of misclassification of sarcoma due to the changes in the diagnostic criteria for uterine smooth muscle tumor over the last decades[26]. Fourth, the full medical records of all hysterectomies were manually reviewed by a gynecologist, thus reducing potential bias

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introduced by differences in the interpretation of the collected variables. This allowed for higher diagnostic accuracy compared with the use of administrative data or to inaccuracy of procedure coding.

The present study also has a number of limitations. First, the low number of sarcomas in our cohort and the resulting lack of statistical power did not allow us to perform further risk-stratification and to identify predictors of unexpected sarcoma. Second, since the majority (>95%) of women resident in Olmsted County are white, the results of our study are not generalizable to populations with different ethnic, social, and economic characteristics; however, results obtained using REP database have generally been consistent with the entire United States population[27]. Third, in our cohort not all patients with uterine sarcoma underwent preoperative biopsy and imaging, raising concerns on whether these procedures should be always included in the preoperative assessment of women undergoing hysterectomy for benign disease. However, since these procedures have low sensitivity in diagnosis of uterine sarcoma[25], they were not routinely used in the preoperative assessment of women undergoing hysterectomy for a benign indication. Preoperative diagnostic techniques continue to improve and routine use will be more common.

Our study has substantial implications for public health. Because there are not reliable markers that allow us to distinguish between uterine fibroids and sarcomas during the preoperative management, the age-specific and uterine weight-specific risks of unexpected sarcomas should be used for preoperative informed consent and counseling of women with presumed uterine fibroids. The risk of unexpected sarcoma should be balanced with the increased risk of surgical complications associated with preventing the use of minimally invasive procedures[28]. New technologies to allow diagnosis of sarcoma in the preoperative setting and to minimize the risk of dissemination of malignant cells are warranted to preserve the benefits of minimally invasive surgery in the large incidence of women with benign uterine fibroids.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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AJOG at a Glance example:

Why was this study conducted?

To estimate the incidence of sarcoma among women undergoing hysterectomy for benign indication in a population-based cohort.

What are the key findings?

The present study shows that the incidence on sarcoma is low among women undergoing hysterectomy for a benign indication (1 in 752 surgeries), but increased in women with presumed uterine fibroids (1 in 256 surgeries). Menopausal status, uterine weight, and age are risk factors for sarcoma.

What does this study add to what is already known?

The present study reaffirms that the risk of sarcoma in women with uterine fibroids is not negligible (1 in 256 surgeries). Age-specific and uterine-weights specific risk stratification can be used for preoperative informed consent and counseling of women with presumed uterine fibroids.

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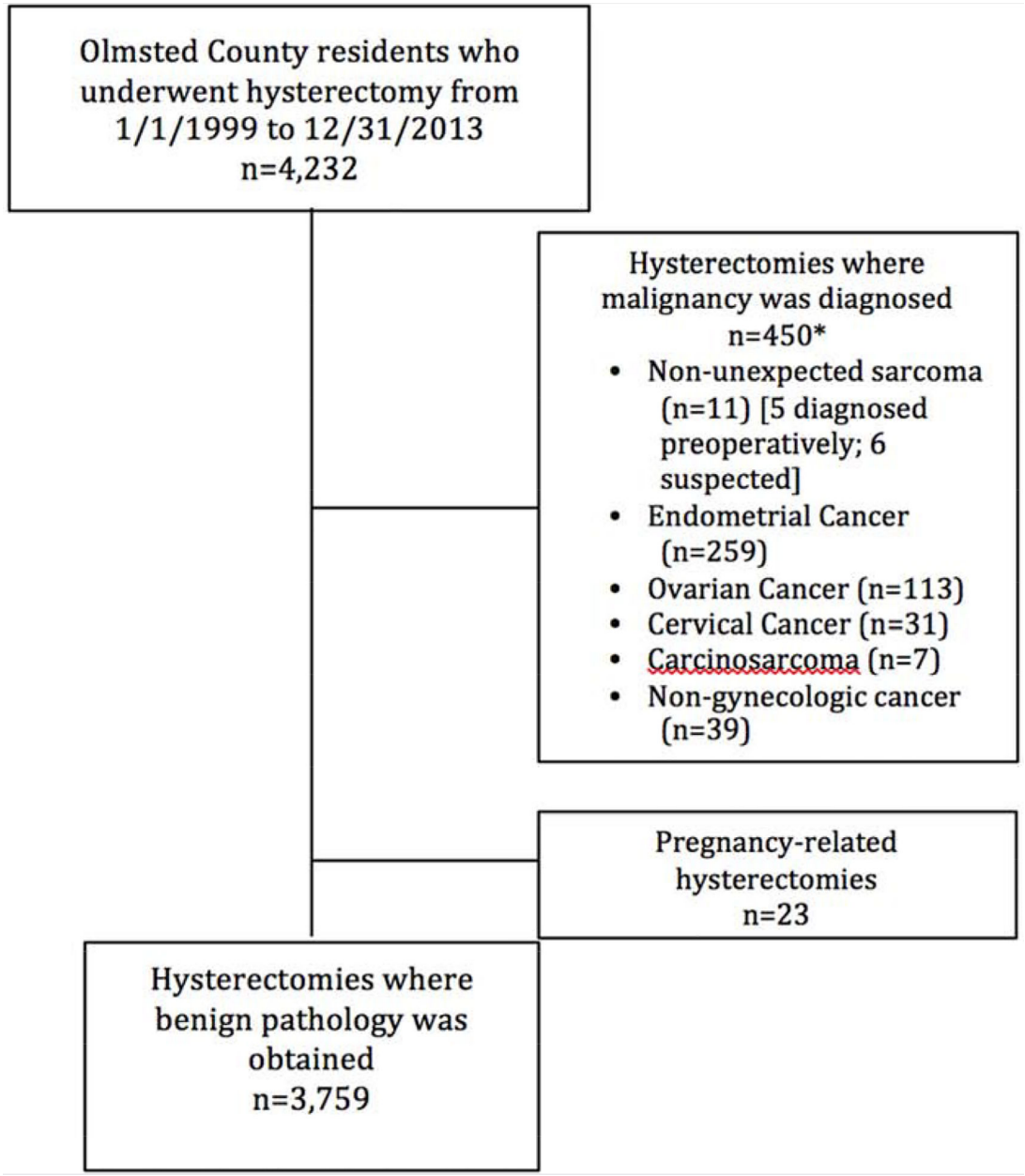

Figure 1.
Flow chart of the study population
*10 women had synchronous cancers.

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Table 1.

Patients' and tumor characteristics of Olmsted County, Minnesota women diagnosed with uterine sarcoma (n=16) from 1/1/999 to 12/31/2013.

	Diagnosis	Age at diagnosis (years)	BMI (kg/m^2)	Menopausal status at diagnosis	Symptoms	Preoperative endometrial biopsy	Preoperative imaging	Surgical approach	Morcellation	FIGO 2009 staging for uterine sarcoma	Tumor grade	Largest tumor dimension (cm)	Uterine weight (grams)	Vital status
	Indication: Uterine fibroids													
1	LMS	55	34	Post	Pelvic pressure	Not performed	Ultrasound	Open	No	IB	Grade 1	14	1325	DOD after 6 months
2	LMS	45	29	Pre	Heavy menstrual bleeding	Not performed	Ultrasound	Open	No	IB	Grade 3	8.5	1150	NED after 12 years
3	LMS	50	35	Pre	Heavy menstrual bleeding	Not performed	Ultrasound	Open	No	IVA	Grade 4	15	2290	NED after 1 years
4	LMS	46	38	Pre	Heavy menstrual bleeding	Not performed	Ultrasound	Open	No	IB	Unknown	18	2641	NED after 4 years
	Indication: Pelvic organ prolapse													
5	Low-Grade ESS	76	32	Post	Pelvic Organ Prolapse	Not performed	No	Vaginal	No	IA	Low Grade	3.5	175	NED after 4 years
	Indication: Uterine mass of unknown origin suspicious for malignancy													
6 ǂ	Adenosarcoma	64	49	Post	Pelvic pain	Not performed	Ultrasound, CT scan	Open	No	IA	Unknown	4	230	NED after 12 years
7	ESS	59	23	Post	Pelvic pain	Not performed	CT scan	Open	No	IVB	High Grade	10	650	DOD after 4 months
8	Low-Grade ESS	43	27	Pre	Unknown	Not performed	Ultrasound, MRI	Vaginal converted to robotic for staging	Yes	IB	Low Grade	7.5	275	NED after 5 years
9	ESS	53	Unknown	Post	Pelvic pain	Not performed	Ultrasound	Open	No	IIA	Low Grade with focal areas of High Grade	15	1,075	DOD after 4 years
10	ESS	65	40	Post	Post-menopausal bleeding	Yes: no abnormal pathology	CT scan	Open	No	IB	High grade	14	1,490	DOD after 3.years
11 ǂ	Low-Grade ESS	52	30	Post	Post-menopausal bleeding	Not performed	Ultrasound	Open	No	IA	3	3	140	DOD after 4 years
	Indication: pre-operatively diagnosed uterine sarcoma													
12	Adenosarcoma	58	24	Post	Post-menopausal bleeding	Yes: diagnosis of sarcoma	MRI	Open	No	IA	Low Grade	7	270	NED after 6 years
13	Low-Grade ESS	34	30	Pre	Heavy menstrual bleeding	Not performed	Ultrasound	Open	No	IB	Low Grade	20	1501	NED after 10 years
14	LMS	61	32	Post	Post-menopausal bledding	Yes: diagnosis of sarcoma	Ultrasound	Open	No	IVB	Grade 4	9.5	840	DOD after 3 months
15	Rhabdomyosarcoma	60	28	Post	Post-menopausal bleeding	Yes: diagnosis of sarcoma	CT scan	LAVH	No	IB	Unknown	7.5	273	DOD after 2 years

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	Diagnosis	Age at diagnosis (years)	BMI (kg/m^2)	Menopausal status at diagnosis	Symptoms	Preoperative endometrial biopsy	Preoperative imaging	Surgical approach	Morcellation	FIGO 2009 staging for uterine sarcoma	Tumor grade	Largest tumor dimension (cm)	Uterine weight (grams)	Vital status
16	LMS	47	39	Pre	Incidental finding on imaging	Not performed	CT scan	Open	No	IVB	Grade 1	9.5	585	NED after 11 years

DOD: Dead of disease; ESS: Endometrial stromal sarcoma; CT: Computed tomography; LAVH: laparoscopic-assisted vaginal; LMS: Leiomyosarcoma; MRI: Magnetic resonance imaging; NED, no evidence of disease.

[ǂ] A frozen section biopsy changed the surgical approach

[≠] A cervical biopsies indicated malignancy

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Table 2.

Incidence of unexpected uterine sarcoma based on preoperative surgical indication and menopausal status, among 3,759 hysterectomies performed for benign indications among residents of Olmsted County, Minnesota, from 1/1/1999 to 12/31/2013.

Stratum		N (%) with unexpected sarcoma within each stratum		
Indication for hysterectomy	**Menopausal status**	**LMS**	**Low-Grade ESS**	**Total [95% CI]**
Uterine fibroids	**Pre (N=851)**	3 (0.35%)	0	3 (0.35%) [0.07 – 1.03%]
	Peri-/Post (N=174)	1 (0.57%)	0	1 (0.57%) [0.01 – 3.16%]
	Total (N=1025)	4 (0.39%)	0	4 (0.39%) [0.11 – 1.00%]
Other benign indications	**Pre (N=1792)**	0	0	0 (0%) [0.00 – 0.21%]
	Peri-/Post (N=942)	0	1*(0.11%)	1 (0.11%) [0.00 – 0.59%]
	Total (N=2734)	0	1*(0.04%)	1 (0.04%) [0.00 – 0.20%]
All benign indications	**Pre (N=2,643)**	3 (0.11%)	0	3 (0.11%) [0.02 – 0.33%]
	Peri-/Post (N=1,116)	1 (0.09%)	1*(0.09%)	2 (0.18%) [0.02 – 0.65%]
	Total (n=3,759)	4 (0.11%)	1*(0.03%)	5 (0.13%) [0.04 – 0.31%]

LMS: Leiomyosarcoma; ESS: Endometrial stromal sarcoma.

*Diagnosed in a patient who underwent hysterectomy for pelvic organ prolapse.

None of the High-Grade ESS, Adenosarcoma, and Rhabdomyosarcoma were unexpected.

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Table 3.

Incidence of unexpected sarcoma by age among women undergoing hysterectomy for benign indications in Olmsted County, Minnesota, from 1/1/1999 to 12/31/2013 (n=3,759).

Age at hysterectomy (years)	N (%) with unexpected sarcoma within each age stratum		
	LMS	Low-Grade ESS	Total
<35 (N=357)	0	0	0
35–44 (N=1368)	0	0	0
45–54 (N=1333)	3 (0.22%)	0	3 (0.22%)
55–64 (N=365)	1 (0.27%)	0	1 (0.27%)
65–74 (N=233)	0	0	0
≥ 75 (N=103)	0	1 (0.97%)	1 (0.97%)

LMS: Leiomyosarcoma; ESS: Endometrial stromal sarcoma.

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Table 4.

Incidence of unexpected sarcoma by uterine weight among women undergoing hysterectomy for benign indications in Olmsted County, Minnesota, from 1/1/1999 to 12/31/2013 (n=3,759).

Uterine Weight (grams)*	N (%) with unexpected sarcoma within each weight stratum		
	LMS	Low-Grade ESS	Total
<250 (N=2993)	0	1 (0.03%)	1 (0.03%)
250–499 (N=404)	0		0
500–999 (N=203)		0	0
1000–1499 (N=63)	2 (3.17%)	0	2 (3.17%)
1500–1999 (N=9)	0		0
≥ 2000 (N=13)	2 (15.38%)	0	2 (15.38%)

*Data available for n=3,685 [98.0% of the total number of benign hysterectomies (n=3,759)