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ORIGINAL SCIENTIFIC REPORT

Pathology Evaluation of Reduction Mammaplasty Specimens and Subsequent Diagnosis of Malignant Breast Disease: A Claims-Based Analysis

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Abstract

Background This study aimed to measure the use of pathology evaluation of breast specimens among patients undergoing reduction mammaplasty and assess rates of new diagnoses of breast disease and associated cost.

Methods We analyzed the Truven MarketScan Databases from 2009 to 2015 to identify adult female patients undergoing reduction mammaplasty for macromastia. We recorded patient age, rates of obtaining pathology evaluation, new diagnoses of benign or malignant breast disease after pathology evaluation, and total cost for the surgery encounter.

Results Among 17,738 macromastia patients undergoing reduction mammaplasty, 91.3% (n = 16,193) received pathology evaluation. Pathology evaluation rates were clinically similar across age groups <70 years (90.8–92.1%) and slightly lower for patients ≥70 (85.0%). Among 6987 patients less than 40 years who received pathology evaluation, 0.06% (n = 4) were subsequently diagnosed with malignant breast disease within 3 months, compared to 0.23% in the entire cohort (n = 37/16,193). Pathology claims resulted in an added $307 (SD 251) on average for the breast reduction surgery encounters.

Conclusions Breast tissue after reduction mammaplasty is routinely submitted for pathology evaluation, without consideration of age-based risk for breast cancer. Routine pathology evaluation of breast tissue in patients in lower risk age groups (less than 40 years) required an additional $536,000 on average to detect a single occult breast cancer compared to an added $85,600 to detect a new malignancy in patients 40 years and older. Clinicians and policy makers should consider whether routine pathology evaluation of breast tissue should be individualized based on risk factors for breast cancer.

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Introduction

Reduction mammaplasty is performed in more than 100,000 patients annually in the USA and is one of the most common plastic and reconstructive procedures [1]. The reported incidence of clinically occult breast cancer in breast reduction specimens ranges from 0.06 to 5% in published single-center US studies, where discrepancies in the estimates are attributed to study methodology, specifics of pathology sampling, and inclusion of patients with varying age and risk factors for breast cancer [2–4]. The American Society of Plastic Surgeons (ASPS) Evidence-based Clinical Practice Guideline for Reduction Mammaplasty recommends screening of resected breast tissue "when clinically indicated and after careful consideration of patient history, risks, and benefits" [5]. However, surgeons tend to routinely submit breast specimens for pathology evaluation owing to the nature of breast surgery or institutional mandates [3, 6–8].

Previous studies have shown that the routine microscopic pathology examination of tissue specimens in plastic and orthopedic surgery increases medical cost and is very unlikely to influence patient management [9–14]. Although a new breast cancer diagnosis as a result of breast reduction surgery is a rare event for patients of all ages [2, 9, 15], no rigorous evidence informs the necessity of performing pathology evaluation of breast reduction specimens based on patient risk factors, such as age [16–18]. Furthermore, the added cost and value of routine pathology evaluation of reduction mammaplasty specimens is unknown, particularly among patients in low-risk age groups.

Given the unclear impact of pathology evaluation of breast reduction specimens in women of low-risk age groups, our study sought to measure the national patterns in utilization of pathology evaluation among patients undergoing reduction mammaplasty in the USA. Secondarily, we aimed to assess the rates of new diagnoses of benign and malignant breast disease and associated cost among patients receiving pathology evaluation for reduction mammaplasty surgical encounters and differences based on patient age. We hypothesized that pathology evaluation would be widely utilized following reduction mammaplasty of all ages, despite increased cost of care and relatively low rates of subsequent malignant breast disease in patients under 40 years of age.

Materials and methods

Dataset and cohort selection

The study received exempt status from the Institutional Review Board. We conducted a retrospective cohort study using the 2009–2015 Truven MarketScan Commercial Claims and Encounters and Medicare Supplement/Coordination of Benefit (MarketScan) Databases. The MarketScan databases are comprised of a national sample of beneficiaries from large employers, health plans, government, and public organizations. The dataset includes inpatient, outpatient, and pharmacy encounters for over 40 million enrollees per year, for the duration of time that individuals are enrolled in the included health plan [19]. Each patient has a unique identifier that allows longitudinal evaluation of health care utilization at a population level.

Our study cohort included female patients' age 18 years and older undergoing reduction mammaplasty for macromastia, identified by International Classification of Diseases, (ICD-9-CM) diagnosis codes and Current Procedural Terminology (CPT-4) codes (Appendix 1). Patients were excluded if they were not enrolled in the dataset for at least 12 months before and after the operation to allow sufficient time for preoperative diagnoses of exclusion and evaluation of new diagnoses of breast disease. We excluded patients if they had genetic susceptibility to breast cancer, prior benign or nonspecific breast disease, or prior personal/family history of breast cancer identified by ICD-9 codes (Appendix 1). The full inclusion and exclusion algorithm is outlined in Fig. 1.

Study variables

We categorized patient age into the following groups: 18–29, 30–39, 40–49, 50–59, 60–69, and 70 years and older. We recorded the receipt of pathology evaluation of breast tissue specimens, including gross and microscopic evaluation. Pathology evaluation was defined as having a pathology encounter for examination of breast tissue the same day or within 7 days after the date of reduction mammaplasty (in the event that pathology encounters were billed on the day of the pathology report rather than on the day of surgery). We categorized new diagnoses of breast disease within 3 months of pathology evaluation of reduction mammaplasty specimens into benign and malignant diagnoses. Benign diagnoses included codes for benign neoplasm, cysts, fibroadenosis, and dysplasia. In addition to being considered within the group of benign diagnoses, rates of dysplasia alone as a subgroup were examined. The malignant diagnosis group included patients with codes for malignant neoplasm, carcinoma in situ, or secondary neoplasm of the breast. The CPT-4 and ICD-9 codes to identify pathology procedures and identify new diagnoses of breast disease are included in Appendix 1. We calculated the total cost for the reduction mammaplasty encounters, including all services associated with a macromastia diagnosis that were delivered on the same date as surgery and cost for pathology encounters on the

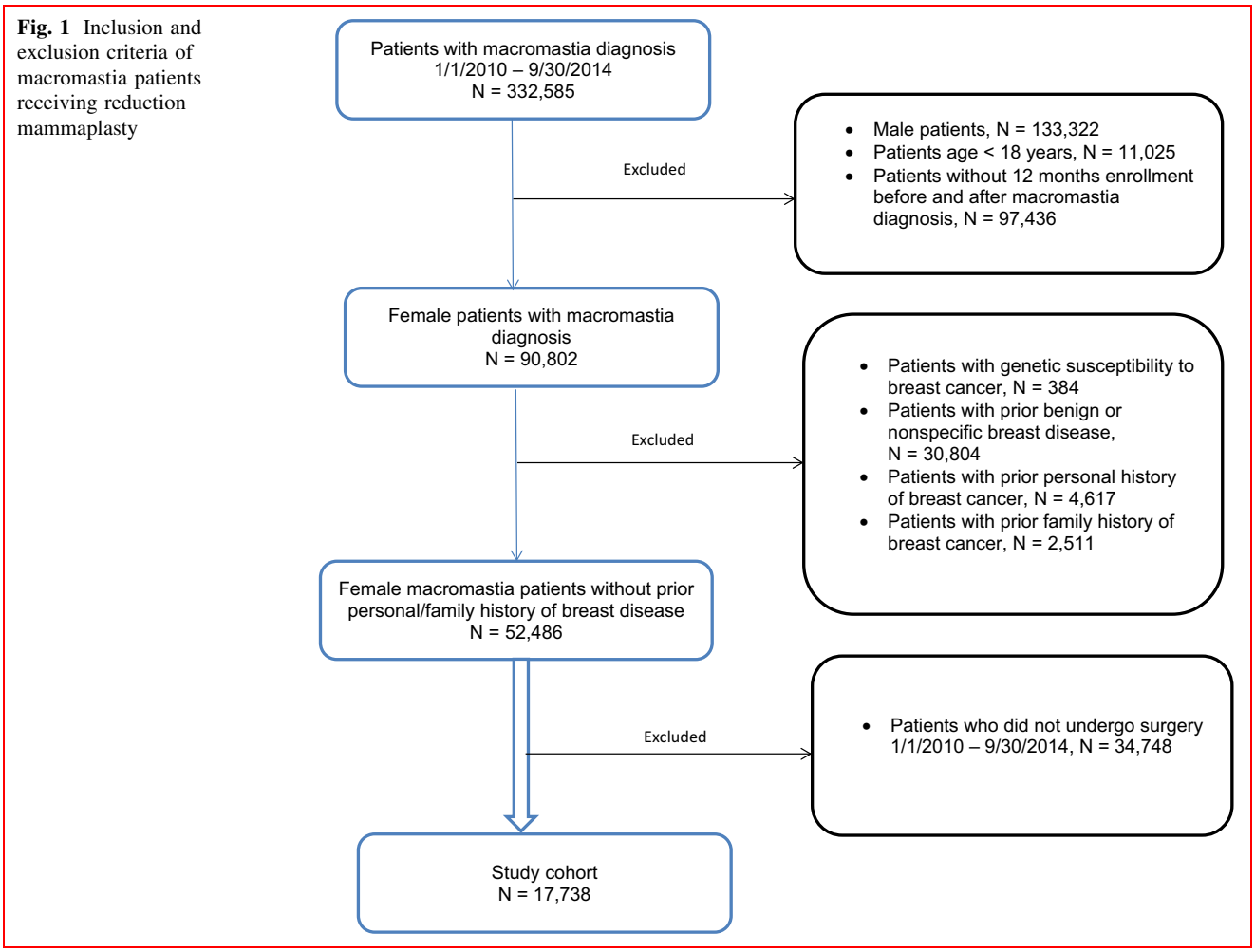

Fig. 1 Inclusion and exclusion criteria of macromastia patients receiving reduction mammaplasty

same day or within 7 days after the surgery. The total cost for the reduction mammaplasty encounters consisted of total reimbursement for facility and provider claims, including insurer payments, coinsurance, copayment, and deductibles. All dollar values were adjusted using the 2015 US consumer price index [20].

Data Analysis

We performed descriptive statistics to assess the age-based rates of pathology evaluation following reduction mammaplasty and frequency of new diagnoses of benign or malignant breast disease after pathology evaluation. The frequency of dysplasia was also determined separately from the remaining benign diagnoses. We compared the average total cost for reduction mammaplasty encounters with and without the use of pathology evaluation, as well as mean costs for pathology claims alone that were greater than zero. Significant differences between mean total costs for the two groups were assessed using Student's *t* test. The number needed to treat and mean additional cost to detect each new breast malignancy or malignancy/dysplasia were calculated.

Results

The study cohort included 17,738 macromastia patients, with a mean age of 41.8 years (SD 13.1), who underwent reduction mammaplasty between January 1, 2010 and December 31, 2014. Among the study cohort, 91.3% (n = 16,193) received pathology evaluation of breast tissue specimens. Of the 16,193 patients who received pathology evaluation, 99.7% received microscopic evaluation (n = 16,140). Use of pathology evaluation was clinically similar across age groups <70 years (90.8–92.1%) and slightly lower for patients 70 years and older (85.0%) (Table 1).

Among all patients who received pathology evaluation after reduction mammaplasty, 0.23% (n = 37/16,193) were diagnosed with new malignant breast disease, 3.1% (498/16,193) were diagnosed with any new benign breast

Table 1 Age-specific rates of pathology evaluation for breast specimens in patients undergoing reduction mammaplasty (n = 17,738)

	Total *N*	Any pathology *N*(%)	Gross evaluation *N*(%)	Microscopic evaluation *N*(%)
Age				
18–29	3571	3290 (92.1)	34 (0.95)	3282 (91.9)
30–39	4039	3697 (91.5)	69 (1.71)	3677 (91.0)
40–49	4560	4147 (90.9)	65 (1.43)	4137(90.7)
50–59	3926	3566 (90.8)	65 (1.66)	3559 (90.7)
60–69	1522	1391 (91.4)	30 (1.97)	1384 (90.9)
≥70	120	102 (85.0)	2 (1.67)	101 (84.2)
Total	17,738	16,193 (91.3)	265 (1.49)	16,140 (91.0)

Table 2 Age-specific incidence of new benign or malignant breast disease after pathology evaluation of breast tissue specimens in reduction mammaplasty (n = 16,193)

	Total	Benign diagnoses		Malignant diagnoses
	N	Any benign diagnosis *N*(%)	Dysplasia *N*(%)	*N*(%)
Age				
18–29	3290	54 (1.64)	1 (0.03)	2 (0.06)
30–39	3697	112 (3.03)	3 (0.08)	2 (0.05)
40–49	4147	128 (3.09)	11 (0.27)	12 (0.29)
50–59	3566	158 (4.43)	13 (0.36)	16 (0.45)
60–69	1391	45 (3.24)	4 (0.29)	4 (0.29)
≥70	102	1 (0.98)	1 (0.98)	1 (0.98)
Total	16,193	498 (3.08)	33 (0.20)	37 (0.23)

disease, and 0.2% (33/16,193) were diagnosed with new breast dysplasia within 3 months of surgery. The diagnosis of malignant breast disease was at least five times lower in patients under 40 years of age (0.05–0.06%) compared to patients age 40 years and older (0.29–0.98%), whereas the diagnosis of dysplasia was at least three times lower in patients under 40 years of age (0.03–0.08%) compared to patients 40 years and older (0.27–0.98%) (Table 2).

Patients who received pathology evaluation after reduction mammaplasty had $918 greater total costs on average (mean $12,387; SD 9348), compared to patients who did not receive pathology evaluation (mean $11,469; SD 11,623) ($P < 0.001$). The mean costs of pathology claims alone that were greater than zero dollars (n = 15,649) were $307 (SD 251). Routine pathology evaluation of breast tissue in patients less than 40 years of age required screening of 1747 specimens to detect a single new occult breast cancer after reduction mammaplasty for an additional $536,000 in cost on average. In comparison, patients 40+ years of age required screening of 279 specimens to detect a single occult breast cancer for an additional cost of $85,600 on average. To detect a new breast cancer or dysplasia requires screening approximately half as many specimens and half of the added costs for both age groups (Figs. 2, 3). For example, 873 specimens were screened for an added cost of approximately $268,000 for women under 40 years of age to detect a new breast cancer or dysplasia.

Discussion

This study showed that breast tissue after reduction mammaplasty is routinely submitted for pathology evaluation without consideration of age-based risk for breast cancer. While occult breast cancer in the setting of breast reduction surgery is rare, rates of breast cancer diagnosis are even lower for younger patients and come with substantial societal costs to detect a single occult breast cancer in low-risk age groups. Even though no specific criteria exist to guide surgeons on the value of ordering routine pathology of breast tissue specimens based on patient risk factors, routine pathology evaluation in low-risk patients may be considered low value if the practice leads to additional cost to patients with little benefit.

Previous single-center studies report rates of occult breast carcinoma in reduction mammaplasty specimens to occur 0.4–1.1% of the time [4, 15, 21–26], with slightly

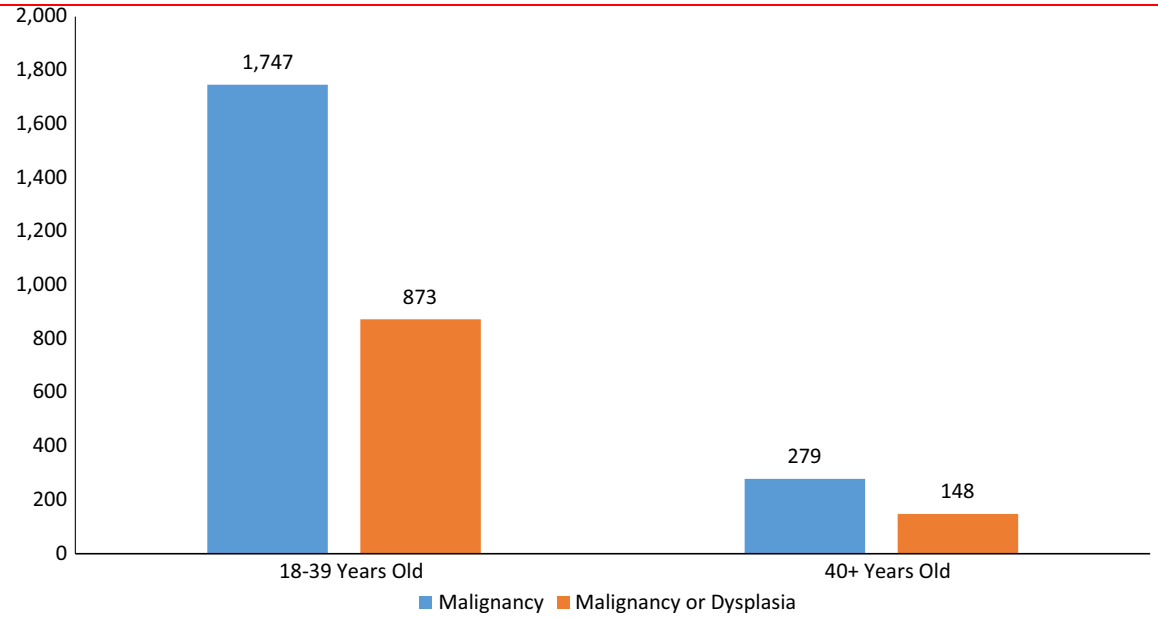

Fig. 2 Number needed to treat to detect new breast malignancy or dysplasia

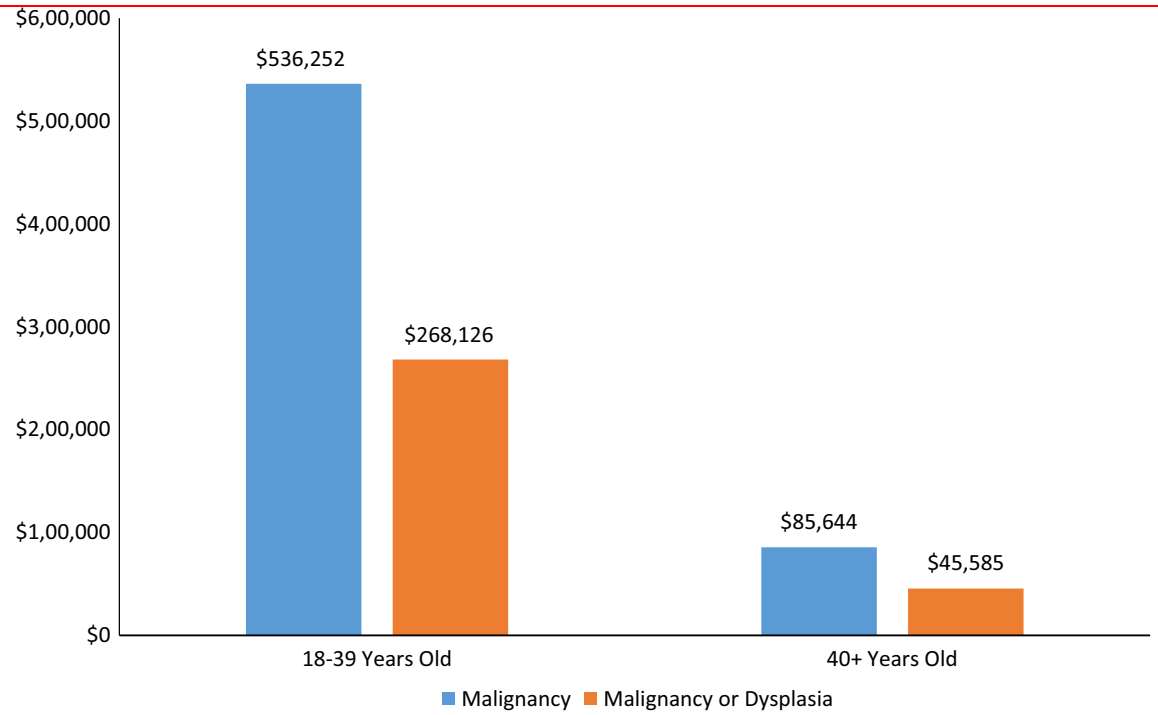

Fig. 3 Added cost to detect single new breast malignancy or dysplasia

higher rates up to 2.4% when patients with a personal history of breast cancer were included in the study cohort [3, 27–29]. Based on the heterogeneity of patient age, inclusion criteria, pathology sampling practices, and sample size of single-center cohorts, slight differences in the incidence of occult breast cancer found in breast reduction specimens are to be expected. The current claims-based study of macromastia patients in the USA found slightly higher rates of occult breast cancer after breast reduction surgery (0.23%) than identified in a previously published

study using Ontario Ministry of Health data, which estimated a 0.06% incidence of occult breast cancer after breast reduction [6]. The Canadian-based study may see lower rates of cancer detection if there were limitations in the ability to track patients longitudinally, for example with migration to private payers or other healthcare systems. Regardless of differences between the findings of this study and previously published single-center and population-based studies, we confirmed that the incidence of occult breast cancer found in breast tissue specimens is a rare event, and studies consistently have found that occult breast cancer is rarely encountered in patients under 40 years of age.

Some authors recommend that pathology analysis of breast tissue specimens should be restricted to high-risk patients, as significant pathology is uncommon in young patients [7, 30, 31], whereas other authors recommended the use of pathology evaluation for all patients to detect occult cancers [8, 32, 33]. However, the Royal College of Pathologists takes the position that the value of random histology in breast reduction is limited [16]. To our knowledge, no clinical practice guidelines explicitly mandate the routine use of pathology evaluation in all patients receiving reduction mammaplasty, although the current study found that in practice breast tissue is routinely submitted for pathology evaluation for patients of all ages. Considering the low risk of cancer in young patients, professional societies should consider whether recommendations for routine pathology evaluation be made based on patient factors for breast cancer rather than submitting specimens for evaluation in all patients. Given the commonality of sending specimens for pathology and perceived medicolegal concerns, surgeons are unlikely to change practice without the support of institutional policy, professional societies, and evidence-based guidelines that recommend high-value care and are based on the best available evidence.

To our knowledge, no studies exist to evaluate the cost-effectiveness of pathology evaluation of reduction mammaplasty specimens. However, some authors have commented on the questionable cost-effectiveness of routine pathology in the setting of young patients undergoing breast reduction surgery [34], whereas others argue for the need for patients to be given the opportunity for shared decision making, especially if they will be sharing out of pocket expenses [35]. From a cost-effectiveness standpoint, the findings of our study demonstrated that patients with tissue submitted for pathology evaluation incurred an additional $307 on average for surgical encounters. For patients under 40 years old, there was an added cost of 536,000 dollars to detect one new breast cancer, compared to an added cost of 85,600 dollars to detect one new breast cancer in patients 40+ years of age. Similarly, there was an added cost of 268,000 dollars to detect a new breast cancer or dysplasia, compared to an added cost of 45,600 dollars to detect a new breast cancer or dysplasia in patients 40–69 years of age. The acceptable added cost to detect a new breast cancer is a question that society or the medical community as a whole must consider. However, this study demonstrates that there is a clear difference in the value of sending pathology specimens based on patient age.

Our study has several limitations. First, prior personal or family history of breast cancer may not be reliably captured by the diagnosis codes owing to the nature of claims-based data, particularly if the diagnosis is more than 12 months prior to reduction mammaplasty and is not documented in recent clinical encounters. Also, we are limited by the lack of clinical data and specificity of ICD-9 diagnosis codes in defining the diagnoses that are included in the benign, dysplasia, and malignant diagnosis groups. In addition, we were unable to know the motivation of ordering routine pathology examination of breast reduction specimens from the claims-based data. For example, we could not confirm whether patients had concerning findings on preoperative breast imaging or physical examination or whether differences in local policies impacted ordering decisions. However, we presume before surgery is scheduled that patients are required to be free of any breast concerns on examination and imaging if indicated per screening guidelines or surgeon recommendation. Furthermore, current recommendations are that patients under 40 years of age should not have routine screening mammograms before elective breast surgery unless a specific concern exists [36, 37]. Although we hypothesize that routine pathology evaluation of breast tissue is a common practice that is reinforced in surgical training with little perceived downside, an understanding of the rationale and facilitators of the practice is outside the scope of this study. Despite these limitations, this study found that routine pathology evaluation is commonplace in a national cohort with rare subsequent diagnoses of malignant breast disease, particularly for patients of low-risk age groups.

Our study assessed the practice of performing pathology evaluation of breast reduction specimens and rates of detecting breast cancer from a national perspective using claims data. Given the low rate of breast cancer and additional cost for pathology evaluation of tissue specimens, future studies are warranted to investigate the necessity of pathology use for patients in low-risk age groups and provider acceptance of potential changes in practice or policy. The study highlights the need for value-based recommendations for the appropriate use of pathology evaluation of breast specimens, which could be applied to other clinical situations in which specimens are routinely sent for pathology evaluation of extremely rare diagnoses. Given the widespread use of pathology evaluation in this

patient population across all age groups, providers are unlikely to change their practice patterns without broad policy that expands beyond local health systems and regions. In the quest for high-value care, clinicians and policy makers should consider whether the practice of routine pathology evaluation of breast tissue should be individualized based on patient age and other risk factors for breast disease to improve value of care.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflicts of interest.

Appendix 1

ICD-9 Diagnosis codes for breast disease	
Macromastia	
611.1	Hypertrophy of breast
Benign/nonspecific breast disease	
217	Benign neoplasm of breast
238.3	Neoplasm of uncertain behavior of breast
239.3	Neoplasm of unspecified behavior of breast
610.0	Solitary cyst of breast
610.1	Diffuse cystic mastopathy
610.2	Fibroadenosis of breast
610.8	Other specified benign mammary dysplasias
Malignant breast disease	
174.0	Malignant neoplasm of nipple and areola of female breast
174.1	Malignant neoplasm of central portion of female breast
174.2	Malignant neoplasm of upper inner quadrant of female breast
174.3	Malignant neoplasm of lower inner quadrant of female breast
174.4	Malignant neoplasm of upper outer quadrant of female breast
174.5	Malignant neoplasm of lower outer quadrant of female breast
174.6	Malignant neoplasm of axillary tail of female breast
174.8	Malignant neoplasm of other specified sites of female breast
174.9	Malignant neoplasm of breast (female), unspecified
198.81	Secondary malignant neoplasm of breast (metastasis)
233.0	Carcinoma in situ of breast
Personal history of malignant neoplasm of breast	
V10.3	Personal history of malignant neoplasm of breast
Family history of malignant neoplasm of breast	
V16.3	Family history of malignant neoplasm of breast
Genetic susceptibility to malignant neoplasm of breast	
V84.01	Genetic susceptibility to malignant neoplasm of breast
CPT codes for breast reduction and pathologic studies of interest	
Bilateral breast reduction	
19318	Reduction mammaplasty
Surgical pathology	
88300	Level I—Surgical pathology, gross examination only
88305	Level IV—Surgical pathology, gross and microscopic examination, including breast, reduction mammaplasty

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