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Cancer Prevalence among a Cross-sectional Survey of Female Orthopedic, Urology, and Plastic Surgeons in the United States

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A B S T R A C T

Background: Exposure to ionizing radiation from fluoroscopy performed during surgery, although low and within established limits, remains a health concern among surgeons. Estimates of breast cancer prevalence among women across surgery specialties with different patterns of fluoroscopy use are needed to evaluate this concern.
Methods: Female U.S. surgeons in urology, plastics, and orthopedics were identified using national directories and mailed surveys to collect information on occupational and medical history, including cancer diagnoses. Standardized prevalence ratios (SPRs) and 95% CIs were calculated by dividing the observed number of cancers among female surgeons in each specialty by the expected number, based on the gender-specific, age-specific, and race-specific cancer prevalence statistics in the general U.S. population.
Results: Standard fluoroscopy use more than once per week was common among urologists (54%) and orthopedists (37%); the same frequency of mini fluoroscopy use was only common among orthopedics (31%) and hardly ever used by urologists. Plastic surgeons reported very infrequent use of any fluoroscopy. For orthopedic surgeons, a significantly greater than expected prevalence of any cancer (SPR, 1.85; 95% CI, 1.19–2.76) and breast cancer (SPR, 2.90; 95% CI, 1.66–4.71) were observed. There was no difference between the observed and expected prevalence of any cancer or breast cancer for urology or plastics.
Conclusions: Using the first available cancer prevalence data comparing female surgeons across three specialties, we report that orthopedic surgeons have a greater than expected prevalence of cancer that may or may not be owing to occupational exposure to ionizing radiation.

Breast cancer is the most common cancer diagnosed among women in the United States (Edwards et al., 2014), as well as the most prevalent cancer, with an estimated 3.1 million women in the United States who carry this history (DeSantis et al., 2014). There are few modifiable risk factors that can be targeted for preventing first time and recurrent breast cancer development (Ligibel, 2011; Scoccianti, Lauby-Secretan, Bello, Chajes & Romieu, 2014). Women in certain occupations are known to be at higher risk compared with the general population (Brophy et al., 2012). For example, female flight attendants and medical radiologic technicians have an estimated 30% and 16% higher risk of breast cancer, respectively, compared with the general U.S. population (Reynolds, Cone, Layefsky, Goldberg & Hurley, 2002; Sigurdson et al., 2003). Hypotheses for increased risk in these occupations include exposure to ionizing radiation (Doody et al., 2006; Sigurdson & Ron, 2004).

Ionizing radiation is an established human carcinogen (International Agency for Research on Cancer, 2012), with sufficient evidence in humans to establish a causal relationship between exposure to x- or gamma-radiation and the development

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of breast cancer (El Ghissassi et al., 2009). Epidemiologic studies have demonstrated that exposure to low-dose ionizing radiation is associated with an estimated 0.4- to 2-fold increase in breast cancer risk (Hill, Preston-Martin, Ross & Bernstein, 2002; Ma, Hill, Bernstein & Ursin, 2008). Surgeons are exposed to ionizing radiation from fluoroscopy performed during surgery. Although efforts are made to reduce exposure with the use of plastic shielding and metal aprons, exposure to radiation is inevitable (Mariscalco et al., 2011; Tuohy, Weikert, Watson & Lee, 2011).

In a recent study, we reported that the female orthopedic surgeons in the United States had a greater prevalence of breast cancer than expected compared with the general U.S. female population (standardized prevalence ratio [SPR], 2.9; 95% CI, 1.66–4.71; Chou, Chandran, Harris, Tung & Butler, 2012). The distribution of established risk and preventative factors associated with breast cancer were compared between the study population of 505 orthopedic surgeons and women in California who participated in the population-based California Health Interview Survey (CHIS). We showed that, compared with the CHIS population, female orthopedic surgeons had a higher prevalence of both protective (i.e., normal body mass index, ever oral contraceptive use, and fewer ever smokers) and predisposing (i.e., fewer children, older age at first full-term birth, more frequent alcohol intake, and longer duration of hormone replacement therapy use) breast cancer factors. Thus, it remained possible that the observed greater prevalence of breast cancer among orthopedic surgeons may be owing, in part, to these predisposing factors or their higher exposure to ionizing radiation, compared with the general U.S. female population.

To evaluate further the hypothesis that female orthopedic surgeons have a greater than expected prevalence of breast cancer that is not solely owing to their reproductive history profile, we conducted similar studies among women in two additional surgery specialties: urology and plastic surgery. The three surgical specialties—plastics, urology and orthopaedics—were chosen specifically because they are considered to represent a spectrum of occupational exposure to ionizing radiation from lowest to highest, respectively (Hellawell, Mutch, Thevendran, Wells & Morgan, 2005). We hypothesized that 1) the distribution of protective and predisposing breast cancer factors will be similar between women in the three surgical specialties (i.e., orthopedics, urology, and plastics), 2) the frequency of fluoroscopy use will be greatest among orthopedic surgeons, and similar between urology and plastic surgeons, and 3) the prevalence of breast cancer among female urology and plastic surgeons will be similar to that of the general U.S. female population.

Methods

Survey Methods

The methods described here to survey female orthopedic surgeons have been described previously (Chou et al., 2012). The following directories were used to obtain the names and mailing addresses of all female urologists, plastic surgeons and orthopedic surgeons practicing in the United States: American Board of Urology 2012 list of board-certified urologists, American Society of Plastic Surgeons 2012 membership directory, and the 2009 American Academy of Orthopaedic Surgeons membership directory. We mailed 1,823 surveys (487 urologists, 612 plastics, 724 orthopedics) along with a cover letter explaining the purpose of the study and a stamped return-addressed envelope. Survey responses were collected between June and October 2012 from the urologists, between March and July 2012 from the plastic surgeons, and between June 2009 and June 2010 from the orthopedic surgeons (Chou et al., 2012).

Participants were asked to provide information about their age, race/ethnicity, subspecialty, years in practice, and type of practice, as well as their current in-office use of fluoroscopy, x-rays, and lead protection. Information related to body size, smoking history, menstrual and reproductive history, use of hormones, mammography, and alcohol use was also collected. History of cancer diagnoses was assessed solely by self-report with the following questions: “Have you had cancer?”, “What type(s) of cancer?”, and “When were you first diagnosed with cancer?” All study activities were approved by the Stanford School of Medicine Institutional Review Board.

Statistical Analysis

Cancer prevalence analyses were limited to all melanomas and invasive internal cancers diagnosed in female clinicians within 15 years of the survey end dates. This 15-year cutoff was introduced to keep our results comparable with the 15-year, limited duration prevalence statistics collected by the National Cancer Institute's Surveillance Epidemiology and End Results (SEER 11) program (Ries et al., 2008). Prevalence statistics from SEER include new and preexisting cases for people alive on a certain date (Howlander et al., 2011). We excluded diagnoses of basal and squamous cell skin cancer (also excluded from SEER statistics), carcinoma in situ, and other cancers that were diagnosed more than 15 years before the survey or did not include a date of diagnosis.

We calculated SPRs by dividing the observed number of cancers among female orthopedic surgeons by the expected number, based on the gender-, age- (10 year groups), and race-specific cancer prevalences in the general U.S. population. For example, the expected number of cases is calculated by multiplying the prevalence rate of each gender–age–race cell by the number of people in our sample in each cell, and then summing. CIs for the SPRs and exact p values were calculated by assuming a Poisson distribution for the observed number of cases, and using an approximation to the exact Poisson test (Breslow & Day, 1987). Although this method is more commonly applied to standardized mortality ratios, it nonetheless provides an accurate test of whether the SPR departs from unity when more than 10 cases are observed (Norvell et al., 2005; van der Gulden & Verbeek, 1992).

Generalized logistic regression was used to model the odds of cancer (both overall and breast cancer separately) as a function of medical specialty (orthopaedics, plastics, and urology), controlling for differences in age and race. Unconditional logistic regression models including variables for age and race were used to calculate odds ratios (ORs), 95% CIs, and p values. Statistical computing was conducted using the SAS version 9.2 statistical software package (SAS Institute Inc., NC). Two-sided tests and alpha of 0.05 was used for analyses.

Results

Of the 1,823 eligible individuals (487 urologists, 612 plastics, 724 orthopedists), 1,203 (341 urologists, 357 plastics, 505 orthopedics) or 66% participated in the study by mailing back the survey. There were 18 women excluded from the analyses owing to leaving a majority of survey questions incomplete. Nearly all