ELSEVIER

Canadian Association of Radiologists Journal xx (2016) 1−9

CANADIAN ASSOCIATION OF RADIOLOGISTS JOURNAL

www.carjonline.org

Health Policy and Practice / Santé: politique et pratique médicale

Detection Rate, Recall Rate, and Positive Predictive Value of Digital Compared to Screen-Film Mammography in the Quebec Population-Based Breast Cancer Screening Program

Isabelle Théberge, PhD[a,*], Nathalie Vandal, MSc[a], André Langlois, MSc[a], Éric Pelletier, MSc[a], Jacques Brisson, MD, DSc[a,b]

[a]*Institut national de Santé Publique du Québec, Québec City, Québec, Canada*
[b]*Department of Social and Preventive Medicine, Faculty of Medicine, Laval University, Québec City, Québec, Canada*

Abstract

Purpose: The study sought to compare performance indicators of computed radiography (CR) using different plate readers, digital direct radiography (DR), and screen-film mammography (SFM) in a population-based screening program.
Methods: This analysis involved women 50-69 years of age who participated in the breast screening program of Quebec (Canada) and who had screening mammogram between January 1, 2007, and September 30, 2012. The detection rate, recall rate, and positive predictive value of CR (n = 672,125 mammograms) and DR (n = 60,023) were compared to SFM (n = 782,894) using mixed-effect logistic regression, adjusting for potential confounders. No institutional review board approval was required.
Results: CR was not associated with change in cancer detection rate (odds ratio [OR]: 0.95; 95% confidence interval [CI]: 0.88-1.03), but with a small increase in recall rate (OR: 1.03; 95% CI: 1.01-1.06) compared to SFM. The association of CR with recall rate varies with the CR plate reader manufacturer ($P < .0001$). DR was not associated with change in detection rate (OR: 1.06; 95% CI: 0.89-1.25), but with an increase in the recall rate (OR: 1.25; 95% CI: 1.19-1.30) compared to SFM.
Conclusions: In our screening program, digital mammograms gave detection rates equivalent to those of SFM, but with an increase of recall rate, particularly for DR. If this situation persists, the adoption of DR may increase the adverse effects of screening with little or no benefit for women.

Résumé

Objet : Cette étude vise à comparer les indicateurs de performance associés à la radiographie sur plaques photoluminescentes (CR) (utilisant différents lecteurs de plaque), à la radiographie à capture directe directe (DR) et à la mammographie sur film dans le cadre d'un programme de dépistage à l'échelle de la population.
Méthodes : L'analyse a porté sur des femmes de 50 à 69 ans qui ont participé au Programme québécois de dépistage du cancer du sein (Canada) et qui ont subi une mammographie de dépistage entre le 1er janvier 2007 et le 30 septembre 2012. Le taux de détection, le taux de rappel et la valeur prédictive positive pour les mammographies faites en CR (n = 672 125 mammographies) et les mammographies faites en DR (n = 60 023 mammographies) ont été comparés à ceux de la mammographie sur film (n = 782 894 mammographies) au moyen d'une régression logistique à effets mixtes ajustée en fonction d'éventuels facteurs de confusion. Aucune approbation d'un comité d'éthique n'a été nécessaire.
Résultats : Les taux de détection des cancers ne s'avérent pas différents en CR comparé à la mammographie sur film (rapport de cotes de 0,95 et intervalle de confiance à 95 % de 0,88 à 1,03). On lui a toutefois associé un taux de rappel légèrement plus élevé (rapport de cotes de 1,03 et intervalle de confiance à 95 % de 1,01 à 1,06) que celui de la mammographie sur film. Cette association entre les mammographies faites en CR et le taux de rappel varie cependant en fonction du fabricant du lecteur de plaque utilisé ($P < 0,0001$). Pour ce qui est du DR, le taux de détection est comparable à celui obtenu par les mammographies sur film (rapport de cotes de 1,06 et intervalle de confiance à 95 % de 0,89 à 1,25). Les mammographies faites en DR ont toutefois obtenues un taux de rappel plus élevé (rapport de cotes de 1,25 et intervalle de confiance à 95 % de 1,19 à 1,30) que la mammographie sur film.

* Address for correspondence: Isabelle Théberge, PhD, Institut national de santé publique du Québec, 945, Av. Wolfe, Québec City, Québec, Canada G1V 5B3.

E-mail address: isabelle.theberge@inspq.qc.ca (I. Théberge).

http://dx.doi.org/10.1016/j.carj.2016.02.001

Conclusions : Dans le cadre de notre programme de dépistage, les mammographies numériques ont obtenues des taux de détection équivalant à ceux de la mammographie sur film, mais des taux de rappel supérieurs à celle-ci, en particulier pour les mammographies faites en DR. Si la situation se maintient, l'adoption de la technologie DR pourrait accroître les effets indésirables des examens de dépistage sans procurer de véritables avantages aux femmes.

Key Words: Breast cancer; Detection rate; Mammography; Recall rate; Screening

Digital technology has gradually replaced screen-film mammography (SFM). Two types of digital technology can be used: computed radiography (CR) or digital direct radiography (DR). CR has the advantage of producing a digital image from photoluminescent plates without changing the mammography unit. DR requires complete replacement of the existing mammography unit, which implies a more substantial investment.

This technological change is likely to have an impact on the accuracy of breast cancer screening [1,2]. Studies that compared screening performance indicators for SFM, CR, and DR, showed conflicting results. Compared to SFM, digital mammography is sometimes associated with an increase of detection rate [3−9], but sometimes not [10−18]. A recent study found a statistically significant reduction of 21% in the detection rate for CR compared to SFM [14]. Digital mammography is also sometimes associated with an increase of recall rate compared to SFM [3−7,12,14,15,17], sometimes not [8−11,13,16,18]. In the context of a randomized clinical trial in United States and Canada, the overall accuracy of digital and screening film mammography were similar [19], but digital mammography was more accurate in women younger than 50 years of age, those with dense breasts, and pre- or perimenopausal women.

In the Quebec Breast Cancer Screening Program (Programme Québécois de Dépistage du Cancer du Sein [PQDCS]), the majority of program centres first converted to CR before adopting DR. Three manufacturers produced CR plate readers used in the program: Fuji (models PROFECT ONE, PROFECT CS; Fujifilm Corp, Minato-Ku, Japan), Kodak (models CR 850, CR 975, Classic CR Elite CR; Carestream Health Inc, Rochester, NY), and Agfa (models CR 35-X, CR 85-X, DX-M; Agfa Healthcare NV, Mortsel, Belgium). Some studies have shown differences in image quality (eg, spatial resolution, signal/noise characteristics) [20−22], glandular breast dose [23,24], or lesion visibility on images [24,25] according to the manufacturer of digital mammography system. To our knowledge, no previous study has compared clinical screening performance indicators according to CR plate reader manufacturer.

Given the contradictory findings concerning the difference in performance of various types of digital mammography technology, we evaluated the association between the type of technology used (SFM, CR, or DR) and the breast cancer detection rate, the recall rate, and the positive predictive value in the PQDCS. We also assessed whether performance varied with the manufacturer of the CR plate reader (Fuji, Kodak, or Agfa).

Materials and Methods

Population

The PQDCS is a population-based organized mammography screening program launched in 1998 that actively invites women 50-69 years of age to receive biennially a screening mammography (craniocaudal and mediolateral oblique views) in accredited centres [26]. Screening mammograms are single read by radiologists who must read, in the years under study, a minimum of 500 mammograms per year. This study is based on 1,585,272 screening mammograms performed within the program from January 1, 2007, to September 30, 2012 (Figure 1). Information on women's characteristics was obtained from self-administered questionnaires completed at each screening examination and retrieved from a PQDCS database. Breast density was assessed by the radiologist who read the screening mammogram. Characteristics of radiologists who interpreted the screening mammograms were obtained from the Quebec College of Physicians directory. Type of screening centre (public, private) was retrieved from PQDCS data. No institutional review board approval was required for this analysis; all study women signed an informed consent allowing their data to be used for program evaluation.

Image Acquisition

Screening mammograms are done in designated centres that must follow a specified quality-control program, which includes regular tests of technical quality to ensure that the mammography unit, processor, and all related equipment are working properly [26]. Centres must also be certified by the Laboratoire de Santé Publique du Québec (LSPQ) [27]. This certification is based on annual examination by a physicist of the installations, the equipment as well as technical image quality [28,29]. Prior to certification, centres must also be accredited by the Mammography Accreditation Program of the Canadian Association of Radiologists where both technical aspects and clinical image quality are evaluated. Certification by LSPQ and accreditation by the Canadian Association of Radiologists of a centre must be obtained for each of its mammography units as some centres have more than 1 unit.

Technology used to perform mammography was obtained from the LSPQ, including the date of change of the mammography unit from SFM to CR or DR systems, and