Variability of mammographic exam doses as a result of positioning and technique

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Introduction

In an oncology institute, dosimetric data pertaining to mammography will include breasts previously submitted to surgery and radiotherapy, in addition to data from untreated breasts. Manual collection of data for dose audits usually focuses on reference situations (untreated breasts). With systems that collect dosimetric data automatically from PACS (Picture Archiving and Communication System), it is now possible to compare exam doses and establish diagnostic reference levels (DRLs) based on very large datasets. Therefore, it seems timely to compare dosimetric data for treated and untreated breasts, to determine if the two should be considered separately in large scale analysis.

Purpose

To establish the baseline of normal variation of dosimetric quantities in mammography, related to variations in positioning and technique. This will serve as a reference for future comparisons between treated and untreated breasts.

Methods

10 patients were randomly selected among those who had multiple mammographic exams archived in PACS and no previous history of surgery or radiotherapy. These patients were submitted to between 4 and 9 exams, performed in the same mammographic unit (GE Senograph DS), in standard automatic exposure mode, over a period of 8 years.

The anonymized images were downloaded from PACS, and a script was written in Python to extract the necessary information: compression force, compressed breast thickness, entrance surface air kerma (ESAK), mean glandular dose (MGD), area and maximum perpendicular width of the imaged region. The area and maximum width were obtained using thresholding, while the other parameters were extracted from the DICOM header. MGD and ESAK values were also calculated independently using the method recommended by EUREF [1].

Results

The mean values of the extracted parameters are presented in the table 1, for each view (Medio-lateral oblique – MLO, Cranio caudal – CC), for all the exams considered.

VIEW	Thickness (mm)	Compression Force (dN)	Area (mm)	Maximum Width (mm)	MGD (mGy)*	ESAK (mGy)
CC LEFT	52.0	92.8	15484.5	105.7	1.2 (1.4)	5.6
CC RIGHT	52.1	97.9	14946.4	103.8	1.2 (1.4)	5.6
MLO LEFT	54.0	104.3	19257.0	113.0	1.2 (1.4)	5.9
MLO RIGHT	54.0	105.6	18967.8	109.2	1.2 (1.4)	6.0

Table 1: Mean values of the different parameters, obtained from the DICOM images.
(*) MGD values in parenthesis were calculated by the EUREF method.

The ESAK values extracted from DICOM agree with the calculated ones, within 10%. Larger differences were found between the calculated MGD values and those indicated by the equipment, depending on breast compositions. These differences are reduced when calculating variations.

For each patient, the mean deviation of each parameter was determined for different views, considering all the exams pertaining to that patient, in different years.

The mean values of these deviations were calculated for this patient group, and are presented in table 2. The most variable parameter proved to be the compression force, which for the same patient (same view, same side) had typical variability between exams around 19-23% of the mean value, reaching more than 30% in some patients.

The maximum width and the area of the imaged region had the least variability, as shown in table 2. Variability of MGD and ESAK was 7-8% and 9-10% respectively, for repeated views of the same untreated breast.

VIEW	Thickness	Compression Force	Area	Maximum Width	MGD*	ESAK
CC LEFT	6%	23%	4%	3%	7% (8%)	10%
CC RIGHT	6%	22%	4%	3%	7% (7%)	9%
MLO LEFT	6%	19%	4%	2%	7% (7%)	9%
MLO RIGHT	6%	20%	4%	3%	6% (7%)	10%

Table 2: Mean values of the mean deviations of each parameter for each view, considering all the exams pertaining to each patient, in different years.
(*) MGD values in parenthesis were calculated by the EUREF method.

Visual comparison of the contours for different years confirms the good reproducibility of positioning, despite small translational variations. As an example, figure 1 shows the contour of different exams for the same patient. The corresponding mean deviation of the parameters obtained for this patient are presented in graph 1.

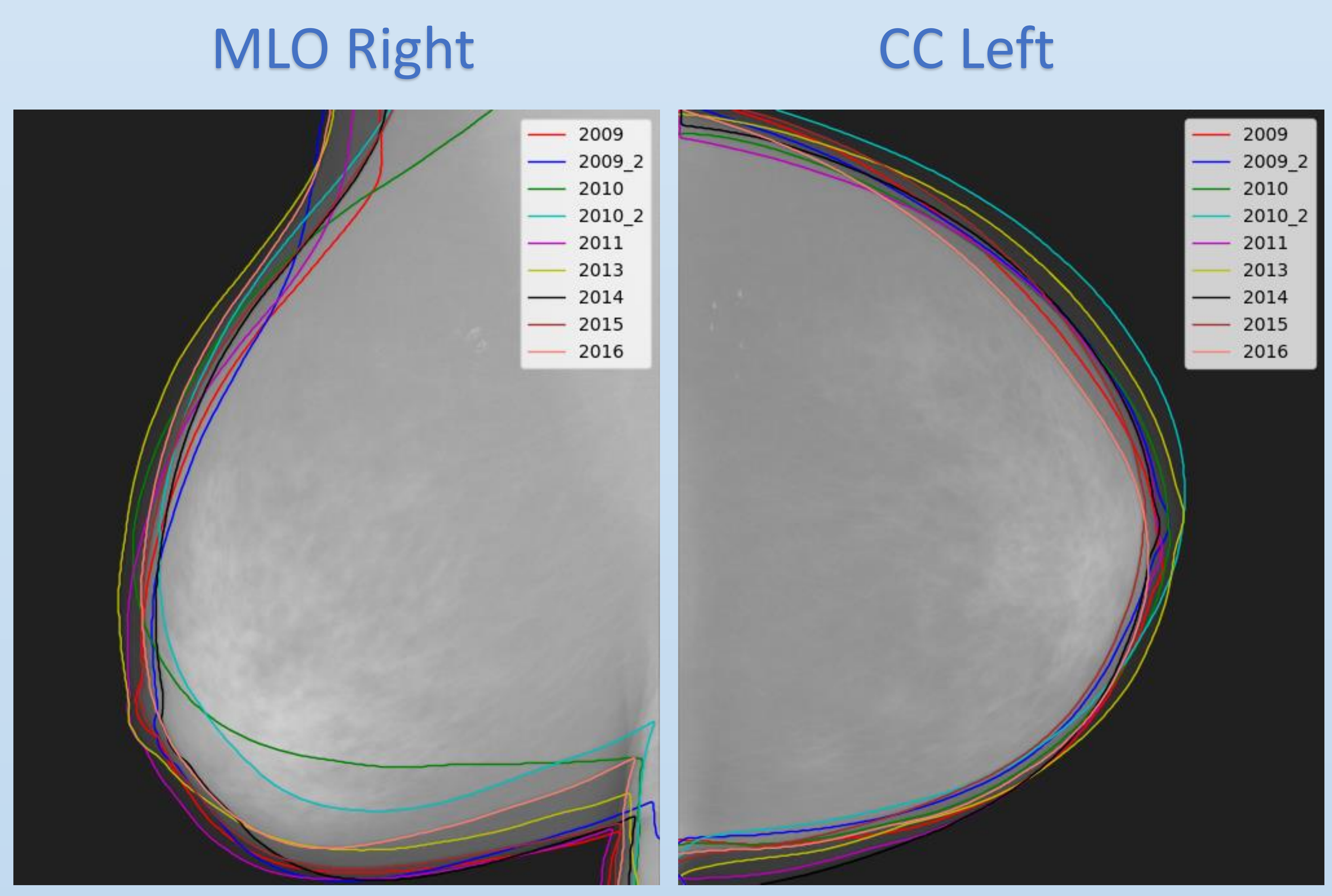
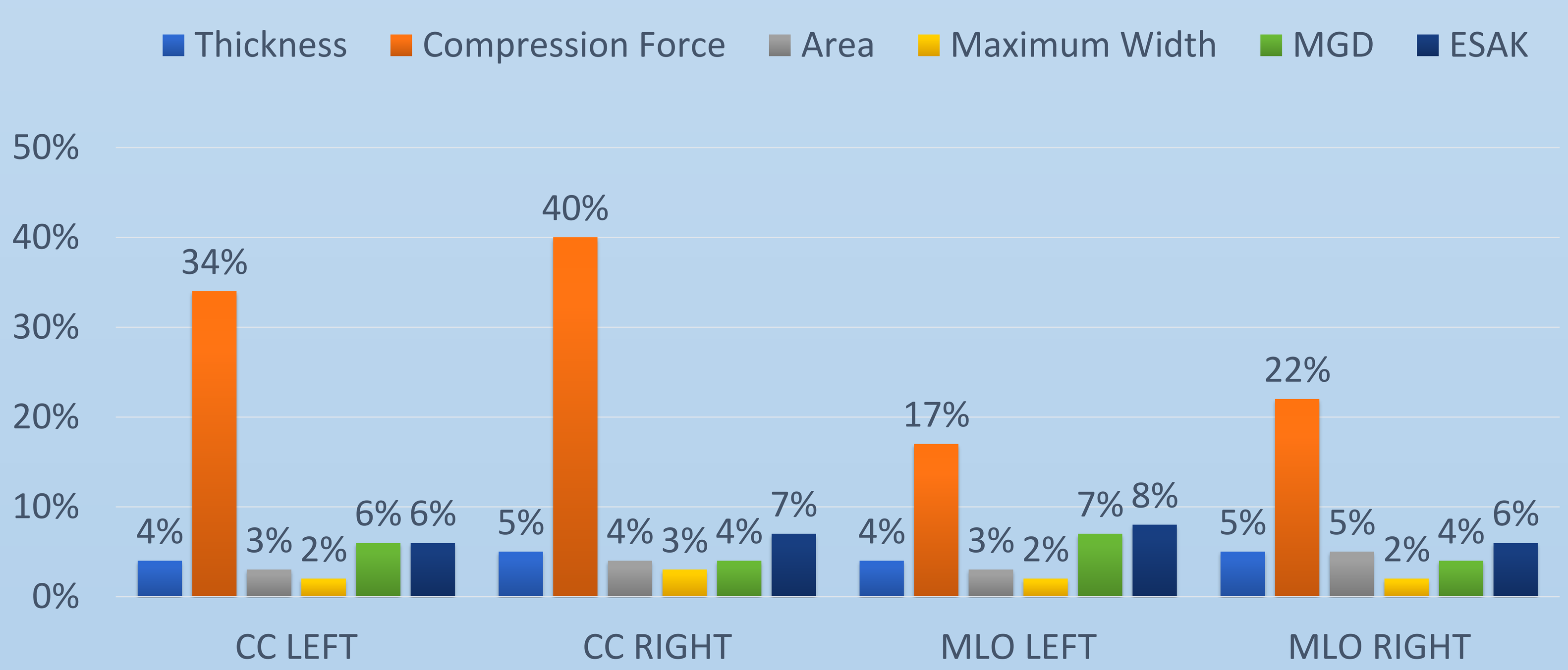


Figure 1: Contours of exams for the same patient throughout the years medio-lateral oblique (MLO) view of the right breast and cranio caudal (CC) view of the left breast.



Graph 1: Variations of the different parameters, corresponding to the patient presented in figure 1.

Conclusion

Variability of exam doses for the same patient was found to be small (less than 10% for MGD and around 10% for ESAK), despite large variations in the compression force. This is probably related to the consistent positioning. The most variable parameter proved to be the compression force.

References

[1] European guidelines for quality assurance in breast cancer screening and diagnosis, Fourth edition (available from *www.euref.org*)

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