White Paper

Breast compression
with SoftSpeed and OpComp
More comfort, more efficiency and more consistency

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The need for breast compression in mammography

Since the early beginnings of mammography, breast compression has been considered an important factor in image quality. It was first described in 1951 by Raul Leborgne, a radiologist from Uruguay, as a way to improve image quality.[1] In the decades that followed, the need for breast compression in mammography has been described extensively and it is now part of standard clinical practice. The key benefits are:

- Reduction of tissue motion, thus avoiding image blurring;
- Lowering the tissue overlap and increasing the utilization of the detector's spatial resolution by spreading out the breast tissue;
- Reduction of the average glandular dose to the breast;[2]
- Reduction of scatter radiation and beam hardening, thus improving contrast and lesion conspicuity;[3] and
- Better use of the detector's dynamic range through uniform breast thickness.[4]

Figure 1a

Figure 1b

The downside of breast compression

Despite its advantages, it is well known that breast compression causes discomfort and even pain in many women. This is predominantly caused by the stretching and spreading of the breast tissue and the resulting strain and changes in physiological tissue dynamics inside the breast.[5]

The effect of compression-related discomfort and pain on compliance should not be underestimated, as fear of pain is a common reason for women not attending screening,[6] and between 25 and 46% of women who stopped attending screening mentioned pain as a reason.[7]

Intelligent compression with SoftSpeed and OpComp

As one of the first vendors to recognize the importance of achieving minimum breast tissue thickness while avoiding discomfort for women, Siemens developed an integrated, intelligent breast compression solution on its mammography systems, called OpComp, which was introduced in 1994. By taking into account differences in breast characteristics, such as size and firmness, OpComp compresses only as long as the breast is soft and pliable. In this way, OpComp finds for every woman the optimal compression needed for good image quality, while avoiding unnecessary discomfort. It has been optimized and refined continuously and is standard on all Siemens mammography systems. Together with SoftSpeed, a two-speed compression method, it helps to improve the comfort for women, the efficiency for radiographers and the consistency for radiologists.

How SoftSpeed and OpComp work

1. Both SoftSpeed and OpComp are fully integrated and automated. The operator of the system only needs to use the foot switches as with conventional mammography compression devices.
2. SoftSpeed involves an automated, two-speed compression paddle movement. When the compression foot switch is pressed, the paddle moves at the first, faster speed and the force on the paddle is continuously monitored (Figure 1a). As soon as the compression paddle touches the breast, SoftSpeed detects that a force is being applied to the paddle and the system automatically switches to the slower compression speed (Figure 1b). The faster movement prior to contact with the breast helps to improve the efficiency, whereas the slower paddle speed aims to provide more client comfort as well as easier and more convenient breast positioning for the radiographer.
3. After this first contact between the compression paddle and the breast, OpComp continuously monitors the breast thickness. This allows the elastic deformation of the breast tissue to be monitored, which is client-specific, non-linear, and depends on the density and microstructure of the tissue. The amount of breast flattening is high at the beginning of the compression and gradually decreases as the compression progresses, as illustrated in Figure 2. So, the mathematical derivative of this relationship, or the gradient $\Delta L/\Delta t$, approaches 0, as illustrated in Figure 2.

4. At a certain point, applying more compression would result in only very small additional thickness reduction and very little additional image quality, yet much more and unnecessary discomfort (Figure 3). At this point OpComp automatically stops the compression, and the best trade-off between image quality and discomfort is achieved. As such, OpComp only compresses as long as the breast is soft and pliable, thereby avoiding unnecessary discomfort.

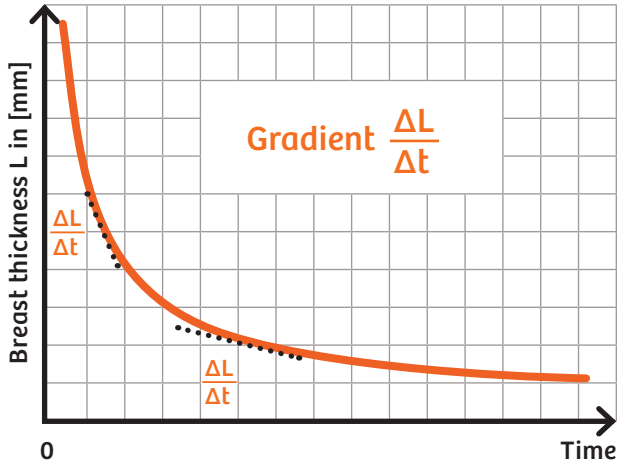

Figure 2

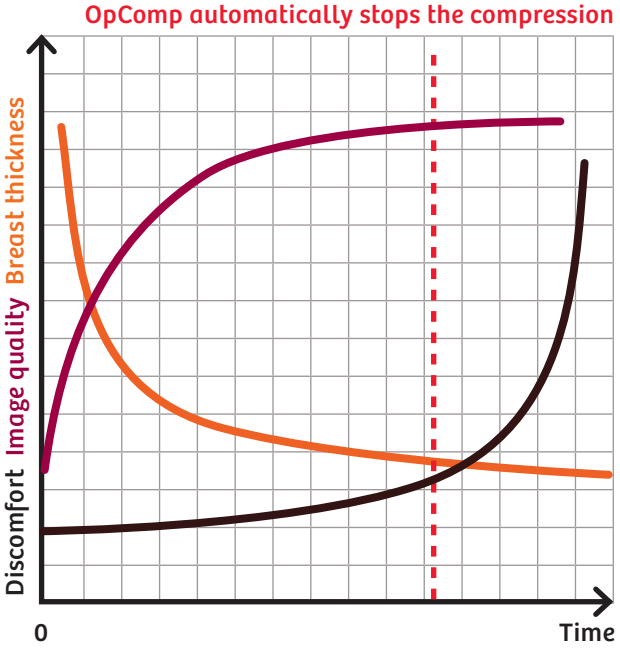

Figure 3

5. A manual override of OpComp is possible with the foot switches and the compression wheel on the gantry, if the operator considers this to be necessary.

6. With SoftSpeed and OpComp, breast compression is determined by carefully defined and refined algorithms that are reproducible and operator-independent. This results in a more consistent image quality, which is important for the standardization needed in breast screening programs. Especially when performing comparisons with priors, such consistent image quality is indispensable.

Discussion

European Guidelines state that "*The compression of the breast tissue should be firm but tolerable*",[8] but do not recommend a guiding measure such as thickness [mm], force [N] or pressure [kPa] or an optimal target value for the compression to be applied to the breast. As explained previously, OpComp effectively measures the firmness, density and microstructure of the breast, which is reflected in the thickness reduction over time (ΔL/Δt). It does not aim for any target value, since the change in breast thickness over time, not the thickness itself or any other absolute measure, is the decisive factor. So, OpComp results in a truly breast-specific yet reproducible compression and provides an automated method that follows the guidelines.

It is generally assumed that the intensity of discomfort or pain depends on the amount of compression applied to the breast. Nevertheless, the existence of individual differences in the subjective experience of pain is well known.[9] The attitudes, opinions and experiences of radiographers also play a major role in the experience of breast compression-related discomfort and pain.[10]

Recent studies indicate that for digital breast tomosynthesis, less compression might be feasible without losing diagnostic performance, due to the 3D nature of tomosynthesis imaging.[11, 12] This might contribute to a better acceptance of mammography and is part of current research. [13]

Summary

Breast compression needs to meet the conflicting goals of a minimum breast thickness for best image quality, while avoiding unnecessary discomfort. Intelligent breast compression with SoftSpeed and OpComp helps to provide

- better mammography experience for women;
- faster and more convenient workflow for radiographers;
- reduced operator variation resulting in consistent and reproducible image quality for radiologists.

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