IMPROVING THE OUTCOMES OF BREAST RADIATION THERAPY: THE PRONE POSITION
Over 230,000 women will be diagnosed with breast cancer this year and approximately half of these women will receive radiation therapy throughout their course of treatment.\(^1,2\)

Radiation is typically delivered in the supine position using tangential fields.\(^3\)

While this position has proven to be both tolerable and effective, it also has constraints which include:

- Increased dose inhomogeneity
- Increased skin reactions due to a bolus effect
- Increased dose to normal structures

The prone position aims to improve breast radiotherapy
There is not currently a universal immobilization protocol for breast radiotherapy and this can vary greatly based on the institution.

Froedtert and the Medical College of Wisconsin utilizes the commercially available C-Qual™ breast board which is capable of being indexed to the treatment table for accurate positioning.

The board includes a head rest, arm rests, and bottom stop which can all be adjusted according to patient comfort and optimal positioning to reduce axillary skin folds.
Prone positioning devices also vary greatly based on the institution but they all achieve the same results.

Froedtert and the Medical College of Wisconsin utilizes a homemade set up which entails:

- Two Styrofoam blocks 14.5 centimeters thick which are indexed to the treatment table approximately 15 centimeters apart.
- A carbon fiber board is placed across the two Styrofoam blocks with a cutout for the affected breast and the contralateral breast is pulled laterally and rests atop the board.
- A customized mold that is placed on the superior block that forms around the patients arms which aims to improve reproducibility each day.
- A pad that is placed on the inferior Styrofoam block to improve patient comfort.
THE SUPINE POSITION

- This position offers many advantages such as:
  - Patient comfort
  - Convenience
  - Maximum available treatment angles
  - Clear visualization of the treatment fields
  - Easier immobilization and reproducibility

- However, this position also allows for significant complications including:
  - Radio-dermatitis
  - Chronic fibrosis
  - Lung & heart toxicity
  - Poor cosmetic outcomes
When the patient is lying prone, it allows for the breast to fall away from the chest wall which opens up the inframammary fold, as well as lateral skin folds, which can ultimately eliminate the bolus effect that would be experienced in the supine position.4,5,7

Bergom et al7 found that only 4.5 percent of their patients treated prone experienced Grade 3 skin reactions.

- When they compared their prone positioning outcomes with a previous supine positioning study, they concluded the prone position offers good and/or excellent cosmetic outcomes in 22 to 36 percent more patients when treated in the prone versus supine position.7
Lymberis et al\(^2\) found that the prone position was better than the supine position in all patients for sparing the ipsilateral lung as the dose was 4.04 Gray (Gy) less than the supine position.

Varga et al\(^8\) had similar findings as they reported a difference of 5.43 Gy in the prone versus supine position.

The reason the dose is able to be reduced so drastically is because the average volume of lung irradiated in the prone position is 103.6 cubic centimeters less than in the supine position.\(^2\)

Lymberis et al\(^2\) also found the prone position was optimal for left sided breast cancer patients 87 percent of the time because it spared the in-field heart volume.
Dose Inhomogeneity leads to an increased risk of long-term edema and fibrosis in the areas of the breast which receive a higher dose.\(^4\)

If the patient is lying prone, it allows for the breast to lengthen anteriorly causing it to narrow the contour which can ultimately provide a more even dose distribution throughout the breast.\(^4\)

Veldeman et al\(^5\) compared both positions and found dose inhomogeneity to be 13.9 percent in the prone position and 15.1 percent in the supine position.

While this is not a large discrepancy between the two positions, it does show that the prone position can offer slightly more homogenous doses to the target volume in breast radiotherapy.
Morrow et al\textsuperscript{6} found that chest wall motion during treatments to be 2.4 millimeters greater in the supine position as compared to the prone position. 

Kirby et al\textsuperscript{9} supports this as they found average chest wall motion to be 2.8 millimeters in the prone position compared to 3.4 millimeters in the supine position. 

These results are consistent with the thorax essentially being immobilized against the platform in the prone position.\textsuperscript{6} 

With these conclusions, it is important to note that Morrow et al\textsuperscript{6} also tracked the patients breathing cycles and found that patient position does not adversely affect respirations.
Many institutions are hesitant to adopt prone positioning due to the belief that interfractional motion is increased.

Veleman et al\(^1\) conducted a study in which each patient was positioned prone and supine and found that interfractional motion on the lateral and longitudinal axis to be very small in both positions, but notably smaller in the prone position.

- The lateral axis required shifts of 0.63 millimeters and 1.49 millimeters for prone and supine positioning, respectively.
- The longitudinal shifts were 0.81 millimeters in the prone position and 1.44 millimeters in the supine position.\(^1\)

However, the largest interfraction discrepancy was along the vertical axis with prone shifts being 7.22 millimeters versus 2.80 millimeters in the supine position.\(^1\)

- They concluded that due to the random nature of the necessary shifts there is “no unifying systemic error inherent in the setup itself.”\(^6\)
- Although these shifts are statistically large, they do still fall into the 20 millimeter margin of tolerance.\(^6\)

Reproducibility in the prone position does appear to be more challenging, but it is achievable as the average interfractional motion remains acceptable.
A factor that affects the reproducibility is the level of patient comfort as many institutes believe that this position is not feasible for certain patients.

Some of the prone positioning platforms are often very hard but Stegeman et al. 3 found that the addition of padding to the boards can improve patient comfort and prevent the risk of rib fractures.

In the same study they also reported that only 4.4 percent of patients reported pain which they considered mild to moderate. 3

Furthermore, prone positioning may actually be more comfortable than the supine position for patients who have:
- Limited shoulder mobility and extension due to musculoskeletal co-morbidities
- Skin contractures from surgery 3

While the supine position may still be more comfortable for some patients, the prone position has proven to be well tolerated.
While the prone position offers optimal treatment outcomes in many instances, there are some situations in which the supine position is required such as:

- Patients requiring irradiation of the chest wall
- A tumor bed that lies deep and posterior in the breast
  - Algan et al\textsuperscript{11} found that 73 percent of patients in their study with deep tumor beds would not have been treated with adequate margins of two centimeters.
- Lymph node coverage
  - Lymberis et al\textsuperscript{2} noted that if their patients had more than one positive lymph node and not undergone a level I and II axillary dissection, their axillary lymph node coverage would not have been adequate.
  - When supraclavicular nodes are involved, it is evident why the prone position would not be an option due to this area being inaccessible.
- Electron boosts due to the difficult accessibility of the scar

In these instances, the supine position would be required and factors such as acute and late toxicities would unfortunately need to be sacrificed.
To provide the best care for all patients regardless of their treatment requirements, it would be worthwhile to investigate alternative delivery methods such as intensity modulated radiation therapy and image guided radiation therapy.

These techniques can be applied to the prone position to further improve its outcomes as well as to the supine position when it is necessary for certain patients.

The goal of these newer modalities is to further reduce the dose to critical structures and ultimately late toxicities of treatment.

Although traditional prone positioning significantly improves outcomes, conducting further research among newer treatment techniques can lead to additional advancements in breast radiation therapy.
REFERENCES


