Comparing immobilisation methods for the tangential treatment of large pendulous breasts

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Abstract Large pendulous breasts pose particular challenges in stabilisation for radiotherapy, due to their inherent mobility. To ensure reproducibility of their positioning between fractions, customised breast immobilisation devices are designed to improve stabilisation and minimise toxicities to the skin and underlying lung. This study aims to review current methods of immobilisation for tangential treatment techniques to the large breast, assessing the range of devices commonly used and discover if any one technique can be recommended. A survey containing 13 questions was sent to 42 randomly-selected centres performing tangential treatments for breast cancer. The questions were designed to assess each centre’s opinion on the effectiveness of the immobilisation device and reproducibility of the breast position for patients with large pendulous breasts. Centres graded their responses using a Likert scale of 1–5, 1 being most effective to 5 being the least effective outcome. Additionally, centres were asked to identify if their current system had any advantages/disadvantages. Ten immobilisation devices were identified from 18 responses to the survey. The prone technique was the most popular, practiced by 22% of respondents. It also ranked consistently well over all in the questions from the survey. The breast board, thermoplastic mask, wireless bra, breast cups, Micropore tape™ (Livingstone International Pty Ltd, Rosebury, NSW, Australia), Vac fix® (S & S Technology, Houston, Texas, USA), stockings, breast rings and plastic L-shaped supports were other devices identified by respondents. None of these other techniques were graded consistently well over the range of survey questions compared with the prone technique. Those using the prone technique were most satisfied with its effectiveness for patients with large pendulous breasts, however, it is acknowledged that the technique is not suitable for all patients.

Keywords: immobilisation, large breasts, lung irradiation, radiation, reproducibility, skin folds, skin reaction, tangential

Introduction

Breasts are a mobile anatomical external structure requiring effective inter fraction immobilisation to ensure reproducibility of positioning.¹ Customised breast immobilisation devices can be tailored to individual patients to stabilise the breast and minimise side effects.² A number of studies have investigated methods of immobilisation for large pendulous breasts, however each has advantages and disadvantages, so devices are commonly department specific.¹

The tangential irradiation of women with large pendulous breasts can be problematic. While patients are lying supine during treatment, large flaccid breasts have a tendency to fall laterally and/or superiorly.¹ If the lateral movement is significant, excessive amounts of lung may be incorporated into the treatment field while trying to ensure adequate posterior coverage of the breast.¹ Excessive skin folds are often present, causing loss of skin sparing, especially in the inframammary fold.

Women with large breasts are also more likely to have a poorer cosmetic outcome after a fractionated course of radiotherapy than women with smaller to medium sized breasts.⁴ Increased acute and late effects are the result of larger field sizes being used to cover the lateral fall of the breast when patients are treated in the supine position.¹ This can result in increased dose inhomogeneities, and often the inframammary fold can have a bolus effect on the breast.⁶ The close proximity of the lung and heart are critical when planning and immobilising breast patients.⁷ Late complications that may result from tangential breast irradiation include lung fibrosis, rib fracture, brachial plexopathy, severe skin erythema and local recurrence.⁸ Effective immobilisation of the breast can aid in minimising the risk and severity of these late complications by consistently reproducing the breast position on a daily basis.

Studies have demonstrated an array of immobilisation devices designed to combat these challenges, however, the focus remains on the most convenient and quickest for treatment technique, rather than the most appropriate to ensure optimal patient outcome. Currently, there is a range of immobilisation devices in use worldwide, however, there is no clear guidance as to which is the most suitable. This research project aims to review current methods of immobilisation for large pendulous breasts and then, based on the results, to make a clinical recommendation for the most suitable device that can be implemented in radiation therapy centres.

Materials and methods

A questionnaire on techniques used for large breast immobilisation and their effectiveness was sent to 42 centres performing tangential treatments for breast carcinoma. These centres were selected randomly within Australia, New Zealand and Great Britain and were chosen to give a more representative evaluation of techniques than would be possible if a study were performed for Australian centres only. All responses have been made
A total of 13 questions were asked, the first identifying the immobilisation device used. The remaining were a combination of yes/no and Likert scaling questions. Participants were asked to grade individual responses using the Likert scale of 1–5, with 1 representing the best outcome and 5 representing the least effective outcome. A grading of three represented a neutral attitude toward a technique. The Likert scale is a way of translating qualitative data into a quantitative format, allowing numerical and statistical comparisons.

The survey required the participants to assess a number of different issues related to the immobilisation device for tangential breast treatment. Questions were as follows:

- Method of immobilisation currently used at the centre.
- The effectiveness of immobilisation.
- If the device was user friendly.
- Reproducibility of breast positioning.
- If the device was reusable.
- Patient comfort.
- Ease in patient maintaining position while using the device.
- If there were decreased skin reactions using the device.
- If it eliminated skin folds.
- Cost of device.
- Ongoing costs.
- Whether or not the device was cost effective.

The questionnaire finished with the option for centres to identify any problems encountered while using that particular method of immobilisation. The authors are aware that centres are providing their own anecdotal experience as opposed to actual scientific measurements when answering the survey questions, however, a benchmark was not established to scientifically measure and compare immobilisation devices at the various centres.

Results

Eighteen responses were returned (43% response rate) from Australia, five from New Zealand and two from the United Kingdom, with 10 different immobilisation techniques currently in use throughout. No particular country was found to be biased towards one specific technique.

Immobilisation device

The 10 breast immobilisation techniques included the prone technique which requires the patient to lie on a polystyrene platform containing an aperture in the centre for the affected breast to hang through in an independent fashion as shown in Figure 1. The breast board provides positioning for tangential treatments with the patient lying in the supine position with the ipsilateral arm raised. Some centres positioned patients on breast boards alone and some used the breast board plus a thermoplastic cast to support both breasts in the preferred position. The thermoplastic cast is clipped onto the sides of the breast board. These were made by submerging the thermoplastic material in hot water and moulding it to the patient’s body. Alternatively, the L-shaped breastplate shown in Figure 2 supports the lateral fall of the breast and reduces the lung volume in the treatment field.

Other centres requested that patients wore an old wire-free bra to support the breast more centrally on the chest wall. Micropore™ tape (Livingstone International Pty Ltd, Rosebury NSW, Australia), was another simple technique used for daily repositioning of the breast. This assisted in holding the breast in position by sticking to the breast skin and then being anchored to either side of the treatment couch.
Vac fix® bags (S & S Technology, Houston, Texas, USA), are also used to position women with large pendulous breasts. The bag is a adaptable cushion filled with polystyrene beads that can be moulded to fit to the patient by evacuating air from the bag while the patient lies in the desired position.

Plastic breast cups come in a range of sizes to accommodate the breast and were reportedly fastened with a non-elastic cloth strapping around the patient’s body for anchoring purposes. The breast ring is commonly a uvex ring of varying diameter that is placed around the base of the breast at the chest wall level. Centres stated that the ring was attached to velcro strapping which is then used to fasten the ring in position around the patient’s body.

An uncommon immobilisation device found in use at the centres was the stocking. This was a light, mesh-like material placed over the breast, enabling the breast to be lifted superiorly into the desired position and thus reducing the inframammary fold.

The most common immobilisation device was the prone technique used by 22% (n = 4) of centres, followed by the breast board being used by 17% (n = 3) of the centres (Figure 3). The least used immobilisation devices were the L-shaped breastplate, the Vac fix®, breast ring and the breast stocking which were only used by 6% (n = 1) of centres.

Effectiveness of immobilisation device

The prone technique was ranked the most effective method for immobilisation for large pendulous breasts, closely followed by the breast ring (Figure 4). The Vac fix® and stocking were both the lowest ranked on the scale for their effective breast immobilisation. The thermoplastic cast, wireless bra and L-shaped breastplate all had similar effectiveness and had a better ranking compared with the stocking and Vac fix®.

User friendly

The breast board and prone technique were given a ranking of 2 and were the most user-friendly devices, while the breast cup was ranked least user friendly with a ranking of 5. The majority of the devices were not very user friendly with the thermoplastic cast, Vac fix®, stocking and L-shaped breast plate all receiving a ranking of 4.

Reproducibility of breast position

The prone technique was clearly ranked the most effective method for reproducing the breast position on a daily basis as illustrated in Figure 5, followed by the breast cup, wireless bra, breast board, L-shaped breastplate and the breast ring. The Micropore™ tape, stocking and Vac fix® were ranked the least effective at reproducing the breast position.

Effective reuse of device

Effective reuse of the devices from one patient to the next was reviewed and 56% (n = 10) of centres agreed their immobilisation device could be reused effectively on another patient, while the remaining 44% (n = 8) were not able to reuse their device. The prone technique reuses the polystyrene platform and breast boards can be routinely reused in themselves. Other devices that can be effectively reused include the L-shaped breastplate, the breast ring and the Vac fix®.

Patient comfort

The wireless bra was ranked the most comfortable immobilisation device for patients (Likert ranking of 1), but one of the least user-friendly with a ranking of 4 as well as being the least reproducible technique. The L shaped breastplate and the breast cup were ranked poorly for patient comfort, with a ranking on Likert scale of 4. The remaining techniques were ranked between 2 and 3 making them average to comfortable for the patient during treatment.

Maintaining patient position

Maintaining the patient position during treatment is essential and all of the devices were given a ranking below 3, indicating no device was difficult for the patient. The device found to be simplest for the patient to maintain her position with was the breast ring; this was given a ranking of 1. The devices found more difficult for patients to maintain their breast position, including the stocking, breast cup, Vac fix® and L-breast plate.

Skin problems

The prone technique was reported to have a reduction in radiation induced skin reaction (Figure 6) compared with other supine techniques. The breast cup was least effective at reducing skin reaction with a ranking of 5. The remaining devices also did little to reduce the skin reaction and were given a score between 3 and 4. No result was recorded for the L-shaped breast board in this particular question.

The elimination of skin folds for the prone technique ranked highly with an average ranking of 1.5 (Figure 7). The breast ring was also effective, while the stocking, breast board and Vac fix® were ranked the least effective at eliminating skin folds.
The average cost to each centre for the different immobilisation devices ranged from no cost where patients used their own bra, to the breast board costing on average $A10,700. The Vac fix® and breast ring were the next most expensive at $A265 and $A150 respectively. The breast cup cost $A60 and the polystyrene prone apparatus was only $A33. No approximate price was given for the L-shaped breastplate, as it was stated the radiation therapy centre absorbed the cost for making the apparatus.

Only 28% (n = 5) of the centres had ongoing costs associated with their immobilisation device, 6% (n = 1) did not complete this question and 67% (n = 12) of centres reported no ongoing cost. New breast cups and thermoplastic casts are used for each patient and are an ongoing cost for centres using them. The polystyrene blocks for the prone technique are replaced every five years due to wear and tear and fresh Micropore™ tape is used daily to immobilise the breasts. One centre also stated that the screws on their breast board had to be replaced annually.

The cost effectiveness of each immobilisation device is shown in Figure 8. The stocking, prone technique, wireless bra and L-shaped breastplate were all cost effective with a ranking of 1. The remaining devices were all ranked moderately cost effective ranging from 2 to 3 on the Likert scale.

Discussion

Women with large pendulous breasts pose problems associated with effective stabilisation for tangential radiation therapy treatment. This can lead to excessive toxicities to both the skin and underlying lung tissue. Of the 13 questions asked, the most important results relate to the reproducibility and practicality of the device, plus the ability to minimise skin folds and toxicities. Based on the results from the survey, these questions were used to assess the best immobilisation device for tangential treatment of large pendulous breasts. Additional questions assisted in identifying other key features of devices used. This study has identified 10 commonly used techniques currently employed in the radiation therapy arena.

Prone position

In this study it was found that the prone technique was the most commonly used, however, due to the limited number of responses this may not be representative of the wider community. A great body of literature supports this technique, as it offers the advantages of eliminating skin folds due to the gravitational effect.
of the hanging breast, therefore reducing the skin reaction.\textsuperscript{5,12} The reduction of skin folds is beneficial to the patient as there is no build up of dose in the underlying tissue.\textsuperscript{6} This reduces the risk of painful and debilitating skin breakdown during treatment, which may require medical intervention or cessation of treatment while the affected skin recovers.\textsuperscript{7} Supine techniques – where the breast falls laterally and superiorly, creating increased skin folds and poor reproducibility – can lead to additional skin problems during the course of treatment.\textsuperscript{5,13}

Using lateral photon fields to treat the breast can significantly reduce dose to the underlying lung tissue as the breast tissue in the prone patient falls away from the chest wall (Figure 9).\textsuperscript{2} Excessive dose to underlying lung tissue may result in late and irreversible complications such as fibrosis causing reduced lung capacity.\textsuperscript{8} However, for tumours located in close proximity to the chest wall, this technique is not suitable due to limited access to the desired area; likewise it is not suitable for treating nodal involvement.\textsuperscript{14}

Reproducibility in the prone position was ranked highly amongst respondents, as breast position remains consistent on a daily basis and therefore reduces human error. Additionally, the gravitational effect allows the breast to hang in an independent fashion away from the chest wall permitting the use of large field sizes to encompass the entire breast.

The prone device can be difficult for some patients to mount depending on their level of physical capability while also being only moderately comfortable. The polystyrene block must be at variable heights in order for different sized breasts to hang freely in the aperture. Any contact of the breast with the couch would compromise this treatment technique.

Larger blocks may prove difficult to pass through the bore of the CT scanner, which could preclude the use of 3D planning techniques. In this instance, an alternative treatment device may be necessary. The prone technique is a cost effective method as the polystyrene blocks cost $10 to make and they can last up to five years, however different sizes may be needed depending on the size of the breast and patient.

Of the centres sampled 22% used the prone technique, which represented the majority. The feedback from these centres indicated they ranked this technique more highly than other techniques described. Based on these results, this study supports the use of the prone technique for the tangential treatment of large pendulous breasts.

Breast board

The breast board with no accessories was the second most commonly used immobilisation device. The board has the advantages of being able to alter the height of the back support in order to achieve a flat sternal angle offering perpendicular beam apposition as well as providing arm supports above the head to give unimpeded access to the treatment area.\textsuperscript{15} While the breast board does not specifically immobilise the breast itself, it does allow for reproducible arm positioning and vertical adjustment.

Vertical adjustment helps to achieve optimal positioning while offering the ability to change the position of the breast in the superior/inferior plane, which minimises skin dose.\textsuperscript{15,16} This is rarely adequately achieved for large breast patients as the vertical adjustments made are generally limited due to technical practicalities of CT scanner bore size. There is no remedial action available to counteract the lateral spread of the breast, which contributes to increasing the lung volume irradiated to achieve lateral coverage.

This device was reported as user friendly for radiation therapists and comfortable for patients provided they have adequate arm mobility. The breast board was ranked highly for its reproducibility, as the breast falls in a consistent position on a daily basis, which can then be validated against skin marks. This position, however, may not always be optimal for tangential treatment.

Breast boards also allow access for nodal treatments such as axilla, supraclavicular region and internal mammary chain if these are to be treated.\textsuperscript{47} While initial outlay is large, breast boards are cost effective as they can be reused for several years.

Thermoplastic cast

The thermoplastic cast is an accessory that is clipped onto the sides of the breast board and moulded to the patient’s body by submerging the thermoplastic material in hot water.\textsuperscript{18} Thermoplastic casts, offer some immobilisation of large breasts by positioning the breast medially and controlling the superior/inferior position of the breast. These devices have been rated as comfortable for the patient and offer average reproducibility.

The principle disadvantage in their use is the increased skin reaction due to the bolus effect of the thermoplastic material and that they only offer a minimal reduction in skin folds.\textsuperscript{18} In addition, manual handling of the breast is required to effectively position and establish consistent reproducibility, which can be unpleasant for both patient and staff. While these devices are not reusable, they are cost effective as they achieve improved breast position when compared to the breast board alone.

Wireless bra

Conflicting reports were received with the use of the patient’s own wireless bra. While the patient comfort was ranked highly, the reproducibility reported was mixed. Wireless bras support the breast more centrally on the chest wall.\textsuperscript{19} However, one centre described the reproducibility as poor, because markers were placed on the bra as opposed to the skin and therefore moved as the garment moved. All centres agreed that skin reaction was increased due to the close contact of bra in areas of skin folds.\textsuperscript{17} This technique, however, is cost effective for the department because the patient provides her own bra.

Breast cup

This device also aims to position the breast more medially on the patient and is strapped around the body with a non-elastic cloth strap to achieve optimal positioning. Again, the breast requires manual handling inside the cup, which can be unpleasant for patient and staff. Reproducibility is less than ideal as staff report difficulty in daily set up, including manual handling of the breast as well as manipulating the breast into the correct position in cups so positioning tattoos are correctly aligned.

Overall, skin reaction was reduced as a result of reduced skin folds while using the cup. However, general skin reactions were only marginally reduced because of the slight bolus effect resulting from the plastic of the cup. Air gaps that are sometimes produced with poor positioning, can also affect the dose distribution.\textsuperscript{4} While these devices are not reusable, they are cost effective as they achieve improved breast position when compared with the breast board alone.

Micropore™ tape

The use of Micropore™ tape in breast positioning was cost effective, comfortable for the patient and reduced skin folds. However, the reproducibility and effectiveness of immobilisation was limited and prone to random set up errors on a daily basis. It also required manipulation of the breast in order to achieve
positioning, which again can be unpleasant for staff and patients. Some patients may also be allergic to the Micropore™ tape itself and this in turn makes the skin reaction worse than anticipated.

**Breast ring**

The uveX breast ring rated highest of all devices surveyed in its ability for patients to maintain position while wearing the device. It was also reported as effective in reproducing the breast position daily as well as comfortable for the patient to wear as perceived by the radiation therapists undertaking the survey. The breast ring is reusable and therefore cost effective after initial purchase costs. Skin folds were reduced due to the ability to position the breast medially, however, skin reaction beneath the ring itself was increased due to a bolus action.

Micropore™ tape, custom made breast cups and breast rings all have the disadvantage of direct contact with the breast often making the acute skin reaction worse due to the device irritating the already radiosensitive skin.

**L-shaped breast plate**

This device aims to position the breast medially by preventing the fall of the breast laterally, and therefore reduces the amount of lung within the treatment field. The L-shaped breast plate gave average results to most questions in the survey. Results showed that this device was rated as being uncomfortable for the patient and not user friendly for staff who had to manipulate the breast into position. It is a reusable device, however, no information was given regarding the cost of the device, although it was noted to be highly cost effective.

**Stocking and Vac fix**

The stocking is made of a light mesh and is placed over the breast, which enables the breast to be lifted superriorly, thus reducing the inframammary fold. The Vac fix® was ranked as comfortable for the patient, however the results from the stocking and Vac fix® were both rated poorly in their ability to reproduce breast position because both are subject to random set up error by the user. The Vac fix® is reusable, while the stocking is not but both are considered cost effective.

The lateral decubitus set up for tangential breast treatment, has the patient lying on the ipsilateral side with the breast tissue compressed to an even thickness of 6 cm to 8 cm, is also reported in the literature. No surveys were returned discussing this technique, but it appears to be an effective method of immobilisation for tumours located away from the chest wall. Again, it is not suitable for nodal irradiation.

**Conclusion**

Conflicting reports on some of the immobilisation techniques have led to inconclusive results. However, the prone technique rated highly in all aspects of the survey when compared with other devices. The study was small and may not be a true representation of centres worldwide, particularly because one radiation therapist per centre answered the survey and those results may differ from the general opinion of that centre. Certain questions regarding patient comfort and ease of maintaining patient position during treatment with the device would be better appraised from a patient’s perspective as opposed to a radiation therapist.

Further study encompassing a larger group of centre specific protocol is needed to clarify findings. Based on this small group, the prone technique whilst not suitable for all large breast patients appears to be popular with the majority of respondents to this survey and we would tentatively recommend further investigation. A full systematic review of the literature and future studies on large breast immobilisation methods would be the ultimate way to provide greater validity to the questions addressed in this study.

**References**


