ISRCTN15283352 https://doi.org/10.1186/ISRCTN15283352

# A new method of estimating the volume of breast tissue removed following breast-conserving surgery using its weight and x-ray appearance

**Submission date**
14/06/2023

**Recruitment status**
No longer recruiting

**Registration date**
14/06/2023

**Overall study status**
Completed

**Last Edited**
16/03/2026

**Condition category**
Cancer

[X] Prospectively registered
[X] Protocol
[X] Statistical analysis plan
[X] Results
[_] Individual participant data

## Plain English summary of protocol

Background and study aims
For women with breast cancer who do not wish to undergo a mastectomy (breast removal), breast-conserving surgery is performed. The cancerous lump is removed together with a rim of healthy tissue and radiation treatment is used to prevent the cancer from coming back. The cancer area may also be treated with extra radiation (boost). In women with smaller breasts and larger breast cancer, some skin and fat from outside the breast area can be used to fill the surgical gap to maintain breast shape and volume. This surgery, however, can make the target area for the radiation boost more difficult to identify. A precise estimate of the volume of removed tissue could be used to confirm that the right area has been identified and ensure that the boost target is neither too large nor too small.
The aim of this study is to develop a method to estimate the removed breast volume using the removed tissue x-ray appearance (fatty or dense) and weight as well as other patient and tumour characteristics. The researchers will also measure the volume with water displacement (a precise but more complex and time-consuming technique) and compare it against the new technique. If proven to be accurate, this quick and simple technique will help to identify the right area to boost and could lead to the development of a better boost technique.

Who can participate?
Any woman with invasive and in-situ breast cancer undergoing breast-conserving surgery (e.g. lumpectomy) will be eligible to participate if the surgery does not involve skin or nipple removal.

What does the study involve?
This study will not result in any change in routine patient care. No additional tests, procedures or hospital appointments are required. In addition to the routine measurements performed in the pathology department after surgery, the volume of the surgical specimen will also be measured. Patient details will not be shared with anyone outside the current treating team of physicians.

What are the possible benefits and risks of participating?
As there is no change in routine patient care, there are no benefits and risks for the individuals taking part in the study.

Where is the study run from?
University Hospitals of Derby and Burton (UK)

When is the study starting and how long is expected to run for?
December 2022 to March 2025

Who is funding the study?
Derby and Burton Hospitals Charity (UK)

Who is the main study contact?
Mr Emanuele Garreffa, emanuele.garreffa@nhs.net

# Contact information

### Type(s)
Principal investigator

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Mr Emanuele Garreffa

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# Additional identifiers

### Integrated Research Application System (IRAS)
325661

### Protocol serial number
UHDB/2019/088

# Study information

### Scientific Title
Development of a new approach to measure the volume of breast tissue removed during wide local excision using specimen weight and mammographic density

## Study objectives

The aim of this study is to evaluate a novel method of obtaining simple and accurate estimates of the volume of a wide local excision (WLE) specimen by putting the specimen weight in relation to its radiological density.

In women with smaller breasts and larger tumours oncoplastic breast surgery techniques such as volume replacement with chest wall perforator flaps (CWPF) can be used to enable breast conservation and avoid deformity. In CWPF, the surgical cavity resulting from WLE is filled volume-for-volume with non-breast tissue (skin and fat) harvested from the surrounding chest wall.

A previous research study demonstrated how, in the context of CWPF volume replacement, the standard approach for tumour bed contouring (based solely on the metal clips placed by the surgeon) is not accurate (contoured volume significantly smaller than specimen volume). A new method of contouring has been proposed including the clips and the typical appearance of the flap in the planning CT scan.

On average, the tumour bed volume obtained with this method closely matched the estimated surgical specimen volume obtained from its weight (only 1.02 ml smaller on average). However, the variability between the individual cases was high (SD 43.6). This is thought to be related to the difference in breast density between the patients leading to a non-accurate estimate of the specimen volume based on its weight.

In the context of volume replacement surgery, having an accurate estimate of the volume of breast tissue removed with surgery could help to increase the accuracy of tumour bed contouring. If the boost volume is underestimated, then the target penumbral breast tissue will be missed (only the central portion of non-breast flap tissue would be irradiated) potentially leading to higher rates of local recurrence. If the boost volume is overestimated, then an excess dose of radiation would be administered with a negative impact on the final cosmetic outcome (increased fibrosis and loss of volume).

During a meeting with a group of breast cancer patients held during the design phase of this study, the importance of accurate radiotherapy planning has been unanimously acknowledged by all participants. In fact, both under- and overestimation of the boost target volume (and subsequent increased risk of local recurrence or impaired cosmetic outcome respectively) could have a negative impact on patients' quality of life and require further treatment including surgery.

To determine the long-term effects of an increased accuracy of the RT boost (impact on local recurrence rate and cosmetic sequelae) is beyond the scope of this initial project due to the timelines of these events. Nevertheless, these aspects could be potentially explored with a long-term study and the findings of the proposed research project will be of key importance in the design of that.

## Ethics approval required

Ethics approval required

## Ethics approval(s)

approved 03/08/2023, London - Fulham Research Ethics Committee (2 Redman Place, Stratford, London, E20 1JQ, United Kingdom; +44 207 104 8084; fulham.rec@hra.nhs.uk), ref: 23/PR/0775

## Study design
Single-centre proof-of-concept study

## Primary study design
Observational

## Study type(s)
Other

## Health condition(s) or problem(s) studied
Patients with breast cancer undergoing breast-conserving surgery

## Interventions
This is a proof-of-concept diagnostic study which evaluates a novel method of obtaining an estimate of the breast volume excised with a WLE by correlating specimen weight and radiological density adjusted for other variables such as age (affecting overall breast radiological density), tumour histology and grade (affecting specimen density as high-grade tumours are denser), and patient's BMI.

In the surgical theatre, following the wide local excision, the surgical specimen will be processed as per standard practice. This involves:
1. Two-dimensional specimen x-ray
2. Measurement of specimen weight

The specimen is subsequently sent (either fresh or in formalin) to the Pathology department for processing. There, in addition to the routine procedures, the specimen volume will be measured by water displacement using the following procedure:
1. The surgical specimen is placed into a graduated jug of known capacity which is subsequently filled completely with water.
2. The specimen is removed, and the water is transferred into a class A measuring cylinder to measure the volume.
3. The WLE specimen volume will be obtained by subtracting the measured water volume from the maximum capacity of the graduated jug.

The histology specimens will be examined and reported according to standard local practice. Additionally, the specimen volume will also be added to the report.

Specimen x-ray density will be assessed by a Radiologist using a Visual Analogue Scale (VAS, 0-100). The presence of a tumour mass and its diameter, as well as the percentage of the specimen occupied by the tumour will also be assessed. A standard procedure on how to assess specimen density with VAS and how to measure the tumour mass will be devised and training will be provided to the radiologists performing the measurements to reduce inter-observer variability.

The breast specimen volume will be modelled using regression analysis, with specimen x-ray density and aforementioned other variables as explanatory variables. This will enable a tailored volume estimate for each specimen.

This study will require two phases:
Phase 1: obtain the equation to predict surgical specimen volumes.
Phase 2 (proof of concept): compare the novel method and the current method (standard density of 0.958 g/ml applied to all samples regardless of their radiological density) with the

gold standard (water displacement). A secondary analysis will also be conducted to establish what percentage of volume estimates will have 5% precision (+/- 5% of the measured specimen volume).

### Intervention Type
Other

### Primary outcome(s)
Comparison between surgical specimen volume estimate obtained with the new regression-based model and actual specimen volume obtained using the gold standard measurement (Archimedes/water displacement method) at the time of surgery measured with Bland-Altman analysis

### Key secondary outcome(s))
Accuracy of the volume estimate obtained with the regression-based model in comparison with the current estimate method using paired t-tests and the Intraclass-Correlation-Coefficient at the time of surgery

### Completion date
31/03/2025

## Eligibility

### Key inclusion criteria
Women with a breast cancer diagnosis (both invasive and in-situ) undergoing breast-conserving surgery with or without oncoplastic techniques

### Participant type(s)
Patient

### Healthy volunteers allowed
No

### Age group
Adult

### Sex
Female

### Total final enrolment
356

### Key exclusion criteria
Excision of skin and/or nipple-areola complex required

### Date of first enrolment
11/10/2023

### Date of final enrolment
30/11/2024

# Locations

### Countries of recruitment
United Kingdom

England

### Study participating centre
**University Hospitals of Derby and Burton NHS Foundation Trust**
Royal Derby Hospital
Uttoxeter Road
Derby
England
DE22 3NE

# Sponsor information

### Organisation
University Hospitals of Derby and Burton NHS Foundation Trust

### ROR
https://ror.org/04w8sxm43

# Funder(s)

### Funder type
Charity

### Funder Name
Derby and Burton Hospitals Charity

# Results and Publications

### Individual participant data (IPD) sharing plan

### IPD sharing plan summary
Data sharing statement to be made available at a later date

### Study outputs

| Output type | Details | Date created | Date added | Peer reviewed? | Patient-facing? |
|---|---|---|---|---|---|
| Other unpublished results | Final sponsor report (includes plain English summary of results) version 2.0 | 20/06/2024 | 16/03/2026 | No | No |
| Plain English results | version 2.0 | 20/06/2024 | 16/03/2026 | No | Yes |
| Protocol file | version 1.0 | 24/06/2023 | 09/08/2023 | No | No |
| Statistical Analysis Plan | version 1.0 | 04/03/2024 | 30/04/2024 | No | No |