

## Recommendations for the aesthetic evaluation of breast cancer conservative treatment

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**Abstract** During the Turning Subjective Into Objective seminar held in Lisbon in May 2011, experts in the topic gathered to discuss the unsolved problems of aesthetic evaluation of breast-conserving treatment (BCT). The purpose of this study is to review the main methodological issues related to the aesthetic evaluation of BCT, to discuss currently used methods of evaluation and the lack of a gold standard, and to write a set of recommendations that can be used as guidance for the aesthetic evaluation of BCT.

**Keywords** Breast cancer conservative treatment · Assessment · Aesthetic results · Recommendations

### Introduction

Breast-conserving therapeutic approaches to breast cancer, aim to obtain, besides local tumour control and survival rates equivalent to mastectomy, better aesthetic results [1, 2]. Whilst the oncological outcome of breast conservation procedures can be easily assessed objectively, aesthetic outcome has yet no standard of evaluation. Due to the diversity of available procedures in breast-conservation, both in surgery and radiation therapy, diverse aesthetic results are expected [3]. This highlights the importance of objective evaluation of aesthetic results in every institution performing breast cancer treatment to assess and improve current strategies, and enable the identification of variables that affect the final aesthetic result [4].

The problems with the evaluation of aesthetic results in breast-conserving treatment (BCT) is three-fold: The first is defining what should be evaluated (which characteristics or parameters are important to consider in this evaluation); the second is how the evaluation should be undertaken (by direct evaluation or by using patients' pictures and if so what kind of photographs are needed and using which conditions; what will be the timing of this evaluation during treatment and follow-up and additionally what scales are going to be used in the evaluation); and third, which method is going to be used (patients' self-evaluation, single or multiple subjective observer evaluation, objective evaluation or even a combination of two or more of the above).

The on-going discussion of all these aspects and the obvious difficulty in agreeing on a consensual and practical

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method for the aesthetic evaluation of BCT has resulted, until today, in the absence of a gold standard method for this type of evaluation.

This motivated us to organise a consensus meeting entitled ‘Turning Subjective Into Objective (TSIO 2011)’ meeting in Lisbon, Portugal. The meeting was attended by experts in this field, familiar with subjective and objective evaluation of cosmetic results of breast cancer local treatment [5–15], who shared their experience to build a set of recommendations, using a nominal group process [16], that could be used as a guide for the aesthetic evaluation of BCT.

## Overview of current evaluation

### General

Methods for aesthetic evaluation of BCT can be divided into subjective and objective. Subjective methods include patient self-evaluation, evaluation by a single observer, or a panel of observers. Objective methods involve several different types of quantifications. For both groups of methods the evaluation can be carried out on the patient or by means of photographs (prints, slides or digital images).

Ideally, the comparison of aesthetic results of BCT would involve the pre-treatment (before surgery and radiotherapy) image of the patient. Unfortunately, the habit of capturing images before initiating treatment is not a rule in the majority of centres dealing with breast cancer. As a consequence nearly all published papers have used the comparison between both breasts, assuming that better results correspond to more similar breasts. Considering that identical breasts are the ultimate aesthetic objective of BCT, asymmetry seems to be the key parameter for analysing aesthetic results.

Asymmetry in breast size is primarily dependent on the amount of tissue excised, particularly when surgery is unilateral [4, 15, 17–23]. Surgery and radiotherapy-associated fibrosis can also impact on symmetry without impairing the size of the breast by causing upward retraction of the inferior mammary sulcus and/or the nipple–areolar complex (NAC) [18, 19]. Scar visibility and length also influences aesthetic results contributing to asymmetry [4, 14, 20, 23]. Other aspects that need to be considered are generally attributed to radiotherapy and include differences in colour, both hyperpigmentation of the treated breast, and hypopigmentation of the NAC complex and to a lesser effect the appearance of telangiectasia [4, 14, 24, 25].

Besides the pre-treatment evaluation there is also the need to repeat this observation at different time intervals during and after treatment (surgery and radiotherapy) as

aesthetic results tend to change over time due to specific effects of these two modalities [23].

### Subjective evaluation

#### *Patient self-evaluation*

Patient self-evaluation is probably the easiest mean for analysis of aesthetic outcomes in BCT. It is surely the one that reflects more the psychosocial adaptation of patients to the aesthetic result [26]. However, its reproducibility is low, because it depends on several factors not amenable to quantification such as age and socioeconomic status [21, 22], factors having a direct impact on how women see themselves after treatment. The main argument in favour of the use of this method is that it is the patient who will have to live with the results of treatment [27]. In studies where comparison of self-evaluation with external observer evaluation was reported, patients invariably evaluated their aesthetic result more favourably [4, 10, 22, 28–33]. One of the plausible explanations is the fear that expressing displeasure may affect their subsequent management [33]. In addition, review of several publications investigating this topic reveals that there is the widespread notion that patients’ evaluation is more related to quality of life (QOL) issues, than to aesthetic features only [10, 21, 34]. The Breast Cancer Treatment Outcome Scale (BCTOS) developed by Stanton et al. in 2001 [34] which includes factors related to cosmesis but also to function (arm movement and breast pain) reported a strong correlation of function factors included in the BCTOS to patients QOL [34–36].

There is little doubt that it is important to obtain patients opinions on aesthetic results, but the low reproducibility of this method makes it inadequate to use for comparison of outcomes between centres [4, 14, 29, 32, 33, 37].

#### *Observer evaluation*

The most widely used method for aesthetic evaluation of BCT is subjective assessment undertaken by one [30, 32, 38–47] or several observers [4, 14, 22–24, 28, 33, 48–55]. This can be done directly, by patient observation, or with photographs using one of the existing scales that compare treated with non-treated breasts.

The most widespread scale used for aesthetic evaluation of BCT in published literature since the beginning of breast-conservation procedures until today is the Harvard scale, introduced by Jay Harris in 1979. It classifies the overall aesthetic results in four categories from excellent, good, fair to poor (Table 1) [31].

In order to examine the aesthetic changes in more detail, Aaronson et al. [56] described the evaluation of 5 specific aesthetic criteria: scar visibility, breast size, breast shape,

**Table 1** Harvard scale

Excellent	Treated breast nearly identical to untreated breast
Good	Treated breast slightly different than untreated
Fair	Treated breast clearly different from untreated but not seriously distorted
Poor	Treated breast seriously distorted

nipple position and skin colour, using the Harvard scale to describe these changes.

Pezner was the first author to question the reproducibility of observer evaluation of aesthetic results in BCT in a series of 14 patients assessed by 44 observers [57]. Substantial consensus was only achieved if the outcome was dichotomized (good versus poor results).

In spite of the limitations of this form of evaluation, it still remains the most widely used method [33, 38, 41, 45, 48, 58]. Excellent and good results associated with low reproducibility values are frequently reported with this type of evaluation [4, 14, 57].

Patients' photographs have made this evaluation easier [4, 57]. Although it is impossible to evaluate oedema, texture and subtle skin changes (atrophy, thickening) in a photograph [4], the practical advantages related to this approach are that an unequivocal and a global appreciation of aesthetic results is obtainable with an inter-observer agreement similar to the one resulting from direct observation of patients [4, 14, 22, 23].

Other scores have been developed with the aim of obtaining a more objective classification [21, 59], but none of them have until now been widely established as an alternative to the Harvard scale.

### Objective evaluation

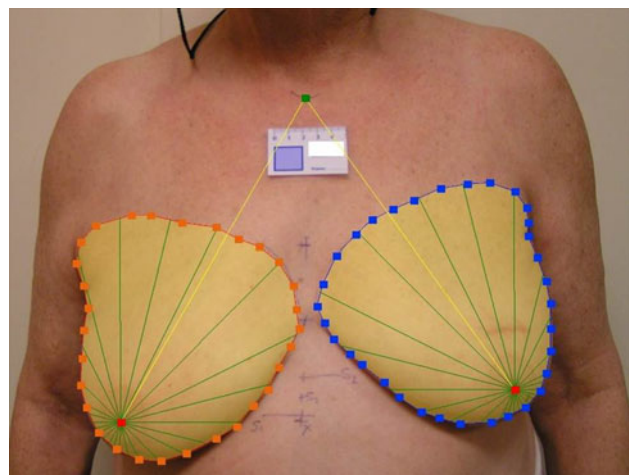
Pezner et al. further developed objective methods of evaluation by introducing the first asymmetry measure for evaluating the treated breast for retraction, the Breast Retraction Assessment (BRA). Using a marked acrylic sheet over the patient's thorax, the upward and inward retraction of the treated versus non-treated breast was calculated. Higher BRA values corresponded to less favourable aesthetic results. BRA was subsequently correlated with tumour size, chemotherapy and radiation fields [18]. Van Limbergen et al. [19] using an identical methodology applied to patient photographs proposed two new asymmetry measurements, in addition to the BRA: the Lower Breast Contour (LBC) and the Upward Nipple Retraction (UNR). A strong correlation was found between the obtained values and a subjective classification undertaken by observers. The same line of thought was followed

by several other authors in more recent work [4, 14, 19, 22, 24, 29, 60].

Noguchi introduced a sum of objective and subjective evaluations. The objective part was undertaken with a Moire's topographic camera, comparing the differences between the displayed curves in both breasts. Other parameters were evaluated subjectively by observers (skin changes and scar) and the final result was the sum of both evaluations [61]. A similar approach was followed by others using both methods and adding the scores to obtain a final result [21, 23].

New approaches have emerged in the last 2 years, arising from two different European research groups.

Fitzal et al. [62] in Austria described a breast symmetry index (BSI), to evaluate the aesthetic outcome of breast conservation. A software called Breast Analyzing Tool (BAT©) was developed to measure differences between left and right breast size from patient's digital pictures (Fig. 1). The sum of all differences results in the BSI, reported as percent difference [%d] or as a difference factor (df). Both units represent differences in size between breasts. The BSI index measured from frontal pictures correlates significantly with subjective evaluation by experts differentiating well between good and fair aesthetic outcome. However, no correlation was found between the BSI index and the patients' opinions. The BSI also did not differentiate well between excellent and good results, or between fair and poor results. The BSI thus can be used to replace subjective analyses with the advantages of increasing reproducibility and shortening evaluation time. This approach improves on the methods described by Pezner [18] and van Limbergen [19], as all quadrants are assessed in addition to nipple retraction. The BSI is also able to differentiate well between good and poor cosmesis



**Fig. 1** BAT software—screen image

with the benefit of requiring only one frontal picture of the patient.

Cardoso et al. [5] from Portugal presented another approach to automated analysis of BCT images, categorizing results as excellent, good, fair and poor. To accomplish this objective, a concise representation of a BCT image is first obtained based on asymmetry, colour and scar visibility features [6]. Asymmetry between breasts is evaluated using a large set of indices, some of them introduced for the first time. To extract colour features of each breast a histogram analysis is carried out followed by an evaluation of dissimilarity. Scar visibility is translated into local colour dissimilarity, by comparing corresponding breast sectors. A correct classification rate of around 70% was obtained when comparing with a consensus evaluation by an expert panel [63].

A software tool was developed to incorporate the aforementioned algorithms: The Breast Cancer Conservative Treatment Aesthetic Results (BCCT.core) (Fig. 2). It introduces user independent evaluation of results preceded by automatic localization of fiducial points (nipples, breast contour and sternum jugular notch) on digital photographs. All measures of individual aesthetic characteristics are automatically reported and this is converted into an overall classification of aesthetic results using the four class scale. Comprehensive reports can be generated and the results stored in a database to facilitate trend and statistical analyses.

The BAT and the BCCT.core software have recently been compared on the same set of cases. Results showed a similar performance on low quality images and a superior performance of the BCCT.core software on higher quality images, perhaps due to the inclusion of colour and scar

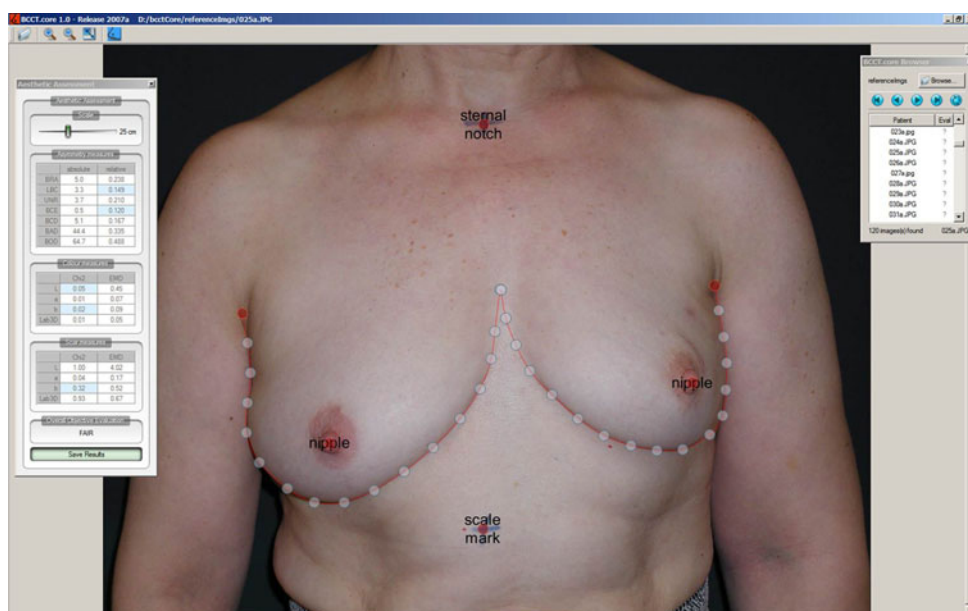
features [64]. The BCCT.core software has been recently used in different studies of aesthetic evaluation of BCT and compared to subjective evaluation methods [8–11].

One of the possible limitations of these methods is the inability to evaluate in three dimensions. Several groups have attempted to use 3D cameras for this purpose [65–68]. Potential advantages of 3D imaging as a tool for objective evaluation of cosmesis include the ability to view the breast from different angles, to estimate volume loss and eventually to plan future interventions. Several variations of this tool exist from relatively simple volumetric analysis to more sophisticated programmes allowing quantitative measurements and thereafter simulation of the likely post-operative outcome. Perhaps the most interesting and consistent attempts in 3D evaluation have been made by Losken et al. [67, 69]. Using a 3D camera and adapted software, they were able to correlate asymmetry, the only evaluated feature in this 23 patient's series, to the amount of resected tissue in relation to breast volume. Results were independent of tumour location, patient's age or need for re-operation. The main drawback of these 3d techniques is the need for specialized hardware, software and personnel. The high cost and the difficulty of using these methods on a daily basis prevented their widespread use.

### The absence of a gold standard

The fifth edition of the European Organisation for Research and Treatment of Cancer (EORTC) manual for clinical research in breast cancer published in 2005 [70] supported the concept of combining qualitative and quantitative evaluation as previously suggested by others [22, 23]. It is

**Fig. 2** BCCT.core software—screen image



advised to use a subjective evaluation by a panel of at least five observers, classifying results according to the Harris scale [31] and an objective evaluation using the measurements of asymmetry described by Pezner [18], with the addition of the Turesson classification for skin damage graded as the area of telangiectasias and skin necrosis [71, 72].

The inclusion of all these important aspects for the aesthetic evaluation of BCT is appealing. However, it has become clear that this system is impractical for routine practice in centres with a medium to large volume of patients. An evaluation of the aesthetic methods used in modern studies illustrates the fact that a gold standard is either not available or not applied (if the EORTC recommendations are to be considered as the gold standard):

Barnett et al. recently published the 2-year results of their randomized trial of forward-planned IMRT for early stage breast cancer patients [73]. The primary endpoint in this study was assessment of breast shrinkage, using photographs taken at baseline and at 2 year follow-up. Changes in breast shrinkage were scored by a panel of clinicians using a 3-point scale (none/minimal, mild and marked). In addition, baseline cosmesis and surgical deficit were assessed before the start of radiotherapy, and the overall cosmesis using photographs was evaluated at 2 years (using a 3-point scale). No objective evaluation was applied.

The ongoing NSABP B-39/RTOG 0413 study, comparing whole breast and partial breast irradiation after breast conserving surgery in women with early stage breast cancer evaluates the aesthetic outcome at baseline, 1 and 3 years of follow-up. The BCCTOS is used as an evaluation of the aesthetic and functional outcome by the patient herself. The physician (radiation oncologist or surgeon) will evaluate the aesthetic result, and finally, digital images will be taken of both breasts for an evaluation of the aesthetic result by a panel of physicians, evaluating the degree of scarring, symmetry between the breasts, extent of pock marks and/or dimpling, and changes to the skin. No objective evaluation will be used.

## Recommendations

With the upcoming new oncoplastic interventions there will be even more demand for the evaluation of aesthetic results. In addition, innovations in radiotherapy with the introduction of partial breast irradiation techniques also have a strong focus on aesthetic results which need to be compared with those of whole breast irradiation. There is therefore the need to fill the gap left by the absence of a gold standard and to define a set of recommendations that can be used, in clinical practice, to evaluate the aesthetic outcome of BCT.

## Patients self-evaluation

It is an important step in the process because it creates a link between QOL and aesthetic outcome. But, it lacks the reproducibility needed to be used in research [10, 74]. It is likely that other QOL parameters are being translated into the result. The BCCTOS is a questionnaire for patients including aesthetic, functional, and pain items. This score is able to separate the aesthetic outcome from other QOL factors and is therefore considered to be the most adequate method for this evaluation [21, 34]. Patients self-evaluation questionnaires should be performed at the same time intervals recommended for other evaluations.

## Patients digital photographs

Patients digital photographs analysis seems to be the most adequate solution to evaluate results [50, 75–77]. Ideally, all kinds of photographs should be amenable to evaluation, but it is possible that some minimum standards for picture quality (definition, backlight, background) will be needed if one is to expect discriminative power in evaluation of aesthetic results. Since a good clinical photograph should provide a maximum amount of relevant clinical information with a minimum of interference, we next enumerate some important conditions.

### Camera

Current consumer compact digital cameras (of superior quality) offer all the necessary quality parameters (spatial resolution, white balance, stabilization technology, etc.) for a good photograph in this setting. The use of flash should be avoided and the recording conditions should render it unnecessary.

### Lighting

The lighting conditions should be controlled to allow a clear photograph of the patient. Asymmetric illumination of breasts should be avoided since it would render comparison more difficult. Lighting should also not allow the projection of strong shadows on the patient's target area.

### Background

If possible, patients should be photographed against a solid coloured background. Light to medium blue is a good choice due to contrast with skin tone. Use a fabric drape or other non-reflective material; Photographs against a one colour wall are also acceptable. Jewellery and clothing create an unnecessary distraction in patients photographs and should be removed before capture.

### Best views

Consistent photography ensures meaningful observations for comparison purposes. The recommended standard photography should include three poses: from the front with hands on hips and both lateral views. We believe these poses best document the patient's breasts without distortion or distraction.

### Camera-to-patient distance

It is important to maintain a consistent magnification between pictures. For a given camera, this may be achieved by controlling the distance from camera to patient. However, required distances are not identical for all cameras. This parameter is affected by imaging sensor size and lens focal length. The recommended framing should go from the sternal notch to the belly button.

### Markings

Manually drawn marks or little round stickers are often used to allow a correct scaling from measures in pixels to values in centimetres or to serve as a reference when comparing different views of the patient obtained with different magnifications. Scales can vary but they must be recorded. If used, we recommend in the face-view a mark is made in the sternal notch with another one 25 cm below, and in the lateral views a mark is made in the axilla, in the inferior limit of the hair line and another 15 cm inferiorly

### Ethical issues and data security

Informed consent should be obtained for every patient before capturing images. If circulation of photographs between centres is needed for research purposes, images must be anonymized before evaluation.

### Timing

Timing for image capture should be standardized. Images must be acquired before any treatment (baseline photograph), before radiotherapy and 1 year after radiotherapy. Images should ideally be repeated at 5 and 10 years follow-up. Loss of follow-up is always a problem in longitudinal studies, and at least with the picture taken at 1 year of follow-up there is a first impression of the aesthetic result. However, given the fact that the aesthetic result continues to change over time, it is important to have as many long term follow-up pictures as possible.

### Subjective evaluation is still recommended

This is due to the absence of a gold standard in the aesthetic evaluation of breast cancer conservative treatment. As a consequence of low values of reproducibility between multiple observers the information of *one expert* (preferably independent of treatment) is considered sufficient to the output [57, 63]. The Harris scale should be used for subjective evaluation, grading results as excellent, good fair or poor (Table 1)[31].

### Objective measurement(s)

This should be added because it is considered to be the most accurate evaluation for asymmetry. The use of one of the known asymmetry measures such as the BRA could be considered sufficient [18, 78].

However, since the BAT and the BCCT.core software allow for automatic and simpler objective measurements that take multiple factors into account, we strongly suggest that one of these methods is used [6, 62].

### 3D evaluation

This has not yet been validated for the purpose and should be considered experimental and if reported always compared with the above proposed recommendations [69, 79–82]

## Conclusions

With the upcoming new oncological and radiotherapy interventions there is an additional need for accurate evaluation of aesthetic results. We hope that this set of recommendations can help us all, to set the standards for a more homogeneous and reproducible evaluation of aesthetic outcome in a more standardized and scientific way. We are aware that there is still further research needed regarding aesthetic evaluation of BCT, and that the evolution of 3D techniques will probably rapidly change the setting in which we now stand.

**Conflict of interest** Maria João Cardoso and Jaime Cardoso are the main developers of the BCCT core software (available free online). The author(s) declare there are no conflicts of interests with respect to the authorship and publication of this article.

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