**kOBCS**: A Novel Software Calculator Program Of The Objective Breast Cosmesis Scale (OBCS)

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Abstract

Background: The Objective Breast Cosmesis Scale (OBCS) was introduced as an objective method to document the breast cosmetic changes using non-standardized photographs without scale-calibration.

Objective: This work test the accuracy and reproducibility of the kOBCS© software tool which invented to simplify the measurement of the OBCS values.

Methods: to prove the mathematical accuracy five schematic drawings of breast-shaped figures were digitally photographed and imported into the kOBCS©. Thirty different photos of breast cancer patients were imported into kOBCS©, twenty different users (experts and non-experts) used the program to evaluate the photographs on two different occasions one week apart. Additionally, a subjective evaluation of each photo was performed throughout the evaluation panel using the Harvard breast cosmesis scale and the results were categorized in two groups; favorable versus adverse cosmesis.

Results: The OBCS values as estimated by the kOBCS© ranged between 1.5 and 13.0 with median value of 4.6. There is a highly significant correlation between the OBCS values based on hand measurements and the OBCS values estimated by the kOBCS©, both values correlate nearly 100% (r= 0.997, P<0.001). There is a strong correlation between the repeated measurements for each user, indicating reliable reproducibility of the program in estimating the OBCS values. Agreement among the users using the kOBCS© was strong with high statistical significance (ICC=0.846, P<0.001, 95% CI: 0.774-0.910, Cronbach’s alpha=0.991). Results of the subjective analyses and mean OBCS values as estimated by kOBCS© correlated significantly (r=0.961, P<0.001).

Conclusions: The kOBCS© is a reliable and reproducible easy-to-use software for reporting breast cosmesis following BCT. The kOBCS© offers a wide range of potential use in different clinical studies that report on the breast cosmesis as one of the outcomes.

Keywords: Breast cancer; objective assessment; cosmetic assessment; OBCS
Introduction

Breast-conserving therapy (BCT) is the standard of care in the management of early-stage breast cancer patients [1–3]. Scoring and documentation of breast cosmesis following BCT is an essential factor in reporting the outcome of the treatment in such patients. Simple comparison between both breasts (treated and non-treated) remains the main approach in reporting the cosmesis. Changes between both breasts results from volume deficit following surgery, quality of the surgical reconstruction, fibrosis, visibility of the scar, and skin discoloration or atrophy following radiation therapy [4–8].

Typically, there are two different methods in scoring the breast cosmesis after BCT, the subjective assessment and the objective assessment. Subjective assessment entails patient self-assessment and observer assessment. Observer assessment is repeatedly used in literature to report the breast cosmesis following BCT [9,10]. Harris et al introduced the Harvard scoring system for reporting the cosmesis outcome depending on the severity of asymmetry between the two breasts [11]. Harvard scoring scale remains the most widely used method in reporting the breast cosmesis [9,10]. Cosmesis assessment based on observation could be carried out by a single observer [9,10,12,13] or based on the sum of assessment from a committee [4,8–10,14,15]. Subjective assessment by a single observer may be considered unreliable, the assessment by a committee with a minimum three members is considered a gold standard for cosmesis evaluation, however it necessitates additional logistics and it is time consuming [15,16].

Some of the introduced measures for objective assessment of breast cosmesis were based on volume evaluation by Mammography, 3D reconstruction of CT or MRI image, laser scanners, or 3D cameras, these methods were complicated and time consuming [17–20]. Other introduced methods included the Breast Retraction Assessment (BRA), Breast Analyzing Tool (BAT©) based on the breast symmetry index (BSI), and The Breast Cancer Conservative Treatment software (BCCT.core) [21–23]. The BRA is performed by applying acrylic sheet over the patient thorax to assess upward and inward retraction of the breast [22]. Both BAT© and BCCT.core require high quality digital photographs with scale calibration [21,23]

The Objective Breast Cosmesis Scale (OBCS) was introduced in a recent study yielding results similar to the results from a multi multidisciplinary/ multi-gender committee. OBCS used non-standardized photographs (without scale-calibration, standardized lighting conditions, standardized digital quality, standardized background, or consistent magnification) which are the most widely used in documenting breast cosmesis during follow-up [24]. The OBCS measures the global breast geometric asymmetry following BCT, a drawback of this score was the time need for measuring the anatomical dimensions and the complexity of the calculation of its formula from a clinician perspective as well as the need for some professional mathematical support. The development of a user-friendly software program to carry out this calculation directly on the assessed photograph was needed to facilitate the use of the OBCS. This work reports on the accuracy and reproducibility of the kOBCS© in clinical use. kOBCS© is a software program calculates the OBCS values directly on the assessed photos.

Methods

OBCS value is the result of a comparison between specific dimensions in both breast; it detects the deviations between both breasts following the treatment procedure through the
changes in the dimensions of two triangles on both sides of the patient. The measured dimensions represent the geometric asymmetry in the terms of nipple displacement, breast dimensions, and breast contours. The result of the comparison between each measured is recorded as a percentage of difference from the non-treated breast. The final OBCS value is the mean of all percentage values. Collectively, OBCS is the percentage of geometric asymmetry between the two breasts. The basic concept of this objective cosmesis scale could be explained as follows; if there were no geometric difference between the two breasts, all the measured dimensions would match completely, the OBCS value would be zero. On the other hand, the OBCS value increases proportionately with the degree of change in the breast size and or shape after treatment. OBCS value less than seven corresponds to a favorable cosmesis result (excellent or good) and values ≥7 represents an adverse cosmesis result (poor or bad) [24]. A software program was invented with collaboration of KBO.COM Srl Università Cattolica del Sacro Cuore Spin off. in order to simplify the measurements and calculations required to estimate the OBCS value; kOBCS© is a digital calculator of the OBCS value. The digital photos could be directly imported into the program and the dimensions required for calculations are measured by placing the different angel points of two automatically generated triangles at the suprasternal notch (SSN), both nipples, and at the point of intersection between the projection of the lateral and the lower breast contours bilaterally, figure-1.

Figure (1): The kOBCS© program with the different measured dimensions and the angle points at SSN, nipples, and the point of intersection between the projection of the lateral and the lower breast contours bilaterally.

Software accuracy
In order to prove the mathematical accuracy of the measurements of the kOBCS©, five schematic drawings of breast-shaped figures were digitally photographed and imported into the OBCS-calculator. The corresponding distances needed for measuring the OBCS were then measured by the OBCS calculator to calculate the OBCS value and the results were then compared with results of the hand –measured distances.

Clinical accuracy and reproducibility
To demonstrate the clinical accuracy and the reproducibility of the kOBCS©, we used 30 different photos of breast cancer patients who were treated with breast conserving surgery
and adjuvant radiation, 15 patients received whole breast irradiation and 15 patients received accelerated partial breast irradiation (APBI) using interstitial multicatheter high dose rate brachytherapy (HDR-BT). The photos were imported into the OBCS calculator software. Ten breast cancer experts (5 radiation oncologists and 5 surgeons) as well as ten non-experts (students) used the OBCS-calculator software to measure the value of OBCS for each photo in two different settings one week apart. Users’ characteristics are summarized in table-1. All users received 10-20 minutes training on how to use the kOBCS© software before the first setting of evaluation.

Table (1): Characteristics of the OBCS-calculator software users.

<table>
<thead>
<tr>
<th>ID</th>
<th>Age</th>
<th>Specialty</th>
<th>Sex</th>
<th>Average no. of breast patients per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>EX.01</td>
<td>43</td>
<td>Surgery</td>
<td>Male</td>
<td>&gt;250</td>
</tr>
<tr>
<td>EX.02</td>
<td>66</td>
<td>Surgery</td>
<td>Male</td>
<td>&gt;250</td>
</tr>
<tr>
<td>EX.03</td>
<td>42</td>
<td>Surgery</td>
<td>Female</td>
<td>100-250</td>
</tr>
<tr>
<td>EX.04</td>
<td>42</td>
<td>Surgery</td>
<td>Male</td>
<td>&lt;100</td>
</tr>
<tr>
<td>EX.05</td>
<td>53</td>
<td>Surgery</td>
<td>Female</td>
<td>&gt;250</td>
</tr>
<tr>
<td>EX.06</td>
<td>37</td>
<td>Radiation oncology</td>
<td>Female</td>
<td>100-250</td>
</tr>
<tr>
<td>EX.07</td>
<td>40</td>
<td>Radiation oncology</td>
<td>Male</td>
<td>100-250</td>
</tr>
<tr>
<td>EX.08</td>
<td>61</td>
<td>Radiation oncology</td>
<td>Female</td>
<td>100-250</td>
</tr>
<tr>
<td>EX.09</td>
<td>38</td>
<td>Radiation oncology</td>
<td>Male</td>
<td>&gt;250</td>
</tr>
<tr>
<td>EX.10</td>
<td>45</td>
<td>Radiation oncology</td>
<td>Male</td>
<td>&gt;250</td>
</tr>
<tr>
<td>ST.01</td>
<td>26</td>
<td>Student</td>
<td>Female</td>
<td>NA</td>
</tr>
<tr>
<td>ST.02</td>
<td>20</td>
<td>Student</td>
<td>Female</td>
<td>NA</td>
</tr>
<tr>
<td>ST.03</td>
<td>23</td>
<td>Student</td>
<td>Male</td>
<td>NA</td>
</tr>
<tr>
<td>ST.04</td>
<td>20</td>
<td>Student</td>
<td>Female</td>
<td>NA</td>
</tr>
<tr>
<td>ST.05</td>
<td>20</td>
<td>Student</td>
<td>Male</td>
<td>NA</td>
</tr>
<tr>
<td>ST.06</td>
<td>25</td>
<td>Student</td>
<td>Male</td>
<td>NA</td>
</tr>
<tr>
<td>ST.07</td>
<td>26</td>
<td>Student</td>
<td>Female</td>
<td>NA</td>
</tr>
<tr>
<td>ST.08</td>
<td>25</td>
<td>Student</td>
<td>Male</td>
<td>NA</td>
</tr>
<tr>
<td>ST.09</td>
<td>28</td>
<td>Student</td>
<td>Male</td>
<td>NA</td>
</tr>
<tr>
<td>ST.10</td>
<td>23</td>
<td>Student</td>
<td>Female</td>
<td>NA</td>
</tr>
</tbody>
</table>

NA: non-applicable.

Clinical subjective correlation

Each of the 20 users was asked to score the same photos subjectively according to the Harvard breast cosmesis grading scale [11]. The final score for each photograph was obtained throughout the scores of the different team members. Score-1 (excellent) was given when the treated breast was nearly identical to the untreated breast; score-2 (good), when the treated breast was slightly different from the untreated; score-3 (fair), when the treated breast was clearly different from the untreated breast but not seriously distorted; score-4 (poor), when the treated breast was seriously distorted. For the comparison, the scores were categorized into two groups; favorable cosmesis (excellent and good) versus adverse cosmesis (poor and bad). The correlation between the results of the subjective scoring and the results of the OBCS was calculated and analyzed.
Statistical analysis

Agreement and inter-rater reliability among users were evaluated with the Cronbach’s alpha as well as with the Intra-class Correlation Coefficient (ICC). ICC value of 0-0.2 indicates poor agreement; 0.3-0.4 indicates fair agreement; 0.5-0.6 indicates moderate agreement; 0.7-0.8 indicates strong agreement; and >0.8 indicates almost perfect agreement [25]. Correlations were plotted as linear regression. Pearson’s correlation was calculated to demonstrate statistical significance, with 2-tailed significance at the 0.01 level. A p-value of 0.05 shows statistical significance. Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 22.0. (Armonk, NY: IBM Corp.).

Results

Cosmesis results

The OBCS values as estimated by the kOBCS© software ranged between 1.5 and 13.0 with median value of 4.6. Twenty-three photos (76.7%) had favorable cosmesis (OBCS<7), while seven photos (23.3%) were scored as having adverse cosmesis (OBCS≥7). The results of the subjective scoring of the same photos according to Harvard scale are summarized in table-2.

Table (2): the results of the subjective scoring of the photos according to Harvard scale.

<table>
<thead>
<tr>
<th>Score</th>
<th>Photos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Score-1 (excellent)</td>
<td>10 (30%)</td>
</tr>
<tr>
<td>score-2 (good)</td>
<td>12 (40%)</td>
</tr>
<tr>
<td>score-3 (fair)</td>
<td>7 (23.3%)</td>
</tr>
<tr>
<td>score-4 (poor)</td>
<td>1 (3.3)</td>
</tr>
</tbody>
</table>

Software accuracy

Accuracy of the kOBCS© software to estimate the OBCS values is demonstrated in figure-2, there is a highly significant correlation between the OBCS values based on hand measurements and the OBCS values estimated by the kOBCS©, both values correlate nearly 100% (r= 0.997, P<0.001).

![Figure (2): Pearson correlation of the OBCS values as estimated by the kOBCS© software and the OBCS values based on hand measurements.](image-url)
Clinical accuracy and reproducibility

Table 3 shows the OBCS values as estimated by using the kOBCS© software program for all users on the two different days. There is a strong correlation between the repeated measurements for each user, indicating reliable reproducibility of the program in estimating the OBCS values. Agreement among the users in estimating the OBCS using the kOBCS© software program was strong with high statistical significance (ICC=0.846, P<0.001, 95% CI: 0.774-0.910, Cronbach’s alpha=0.991)

Table (3): comparison between OBCS values as estimated by the kOBCS© software in two different occasions, one week apart. The linear regression shows a very close similarity between the values of different users, which correlated significantly as shown by the Pearson correlation, test.

<table>
<thead>
<tr>
<th>User</th>
<th>Linear regression</th>
<th>Pearson correlation</th>
<th>User</th>
<th>Linear regression</th>
<th>Pearson correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>r</td>
<td>p</td>
<td></td>
<td>r</td>
<td>p</td>
</tr>
<tr>
<td>EX.01</td>
<td>0.999</td>
<td>&lt;0.001 (1.6 x 10^-22)</td>
<td>ST.01</td>
<td>0.959</td>
<td>&lt;0.001 (6.2 x 10^-17)</td>
</tr>
<tr>
<td>EX.02</td>
<td>0.961</td>
<td>&lt;0.001 (3.6 x 10^-17)</td>
<td>ST.02</td>
<td>0.944</td>
<td>&lt;0.001 (5.3 x 10^-15)</td>
</tr>
<tr>
<td>EX.03</td>
<td>0.999</td>
<td>&lt;0.001 (3.1 x 10^-18)</td>
<td>ST.03</td>
<td>0.912</td>
<td>&lt;0.001 (2.2 x 10^-12)</td>
</tr>
<tr>
<td>EX.04</td>
<td>0.995</td>
<td>&lt;0.001 (5.6 x 10^-19)</td>
<td>ST.04</td>
<td>0.893</td>
<td>&lt;0.001 (3.1 x 10^-11)</td>
</tr>
<tr>
<td>EX.05</td>
<td>0.999</td>
<td>&lt;0.001 (7.1 x 10^-16)</td>
<td>ST.05</td>
<td>0.983</td>
<td>&lt;0.001 (3.6 x 10^-13)</td>
</tr>
<tr>
<td>EX.06</td>
<td>0.998</td>
<td>&lt;0.001 (3.8 x 10^-19)</td>
<td>ST.06</td>
<td>0.999</td>
<td>&lt;0.001 (1.8 X 10^-9)</td>
</tr>
<tr>
<td>EX.07</td>
<td>0.997</td>
<td>&lt;0.001 (1.1 x 10^-22)</td>
<td>ST.07</td>
<td>0.946</td>
<td>&lt;0.001 (3.8 x 10^-14)</td>
</tr>
<tr>
<td>EX.08</td>
<td>0.999</td>
<td>&lt;0.001 (8.6 x 10^-9)</td>
<td>ST.08</td>
<td>0.987</td>
<td>&lt;0.001 (1.4 x 10^-13)</td>
</tr>
<tr>
<td>EX.09</td>
<td>0.961</td>
<td>&lt;0.001 (3.6 x 10^-17)</td>
<td>ST.09</td>
<td>0.999</td>
<td>&lt;0.001 (2.1 x 10^-13)</td>
</tr>
<tr>
<td>EX.10</td>
<td>0.912</td>
<td>&lt;0.001 (2.2 x 10^-12)</td>
<td>ST.10</td>
<td>0.948</td>
<td>&lt;0.001 (1.7 x 10^-21)</td>
</tr>
</tbody>
</table>

Clinical subjective correlation

The correlation between the mean OBCS values as estimated by kOBCS© software for all users and the results of the subjective analyses according to Harvard cosmesis scale are demonstrated in figure-3. There was a strong significant correlation between the both results (r=0.961, P<0.001).

![Figure (3): Pearson correlation between OBCS values by kOBCS© and the results of the Harvard scoring.](image-url)
Discussion
The OBCS was effectively proved to replace the evaluation of an expert panel as well as to correlate significantly with the patient’s self-evaluation [24], which are the most representable methods in evaluating the breast cosmesis following BCT [4,8–10,14–16]. Importance of the patient’s self-evaluation is derived from the fact that it is one of the patient reported outcome indicating the quality of life for a large subset of patients who receive BCT [4,10].

The OBCS is a novel and reliable method in reporting the breast cosmesis; it requires only one non-standardized frontal photo of the patient as it compares the geometrical difference between the two breasts, this advantage has made the use of OBCS in reporting the breast cosmesis fast and accurate.

In the study initially presented OBCS, only photographs of patients treated after surgery with APBI using interstitial multicatheter HDR-BT were used [24], however in the current study we used photographs from patients treated by APBI interstitial multicatheter HDR-BT as well as patients treated by WBI. The kOBCS© was proved to be accurate in estimating the values of OBCS with almost complete correlation with the values of OBCS calculated based on hand-measurements, indicating the mathematical accuracy of the software.

The results of the kOBCS© highly correlated with the results of the subjective evaluation by the panel, the kOBCS© was able significantly to differentiate photos with favorable cosmesis from photos with adverse cosmesis, it does not differentiate between excellent and good or fair and poor cosmesis outcome.

The kOBCS© was demonstrated to be reproducible and could be used easily with high clinical accuracy by both experts and non-experts. The kOBCS© software reduces the time needed for assessment time and necessitates only one frontal picture taken in the outpatient during follow-up. The training to use the program was short but jet yielded results, which correlated significantly with the panel evaluation indicating that the software is user friendly and could be incorporated instantly and easily in the daily clinical practice.

Conclusion
The kOBCS© is a reliable and reproducible easy-to-use software for reporting breast cosmesis following BCT. The kOBCS© offers a wide range of potential use in different clinical studies that report on the breast cosmesis as one of the outcomes.

Acknowledgement
We would like to thank Ádám Kovács from the Technical University of Budapest, Hungary for the help in developing the kOBCS©. We would like also to thank Stefano Gentileschi, Giorgia Garganese, Martina Ricci, Calogero Messana, Alida Savelli, Cesare Marino, and Maria-Vittoria Notari for their help in testing the software.

Conflict of Interest
The authors have no conflict of interest.
Abbreviations

3D: three-dimensional.
95% CI: 95% confidence interval.
APBI: accelerated partial breast irradiation.
BAT©: breast analyzing tool.
BCCT.core: breast cancer conservative treatment software.
BCT: breast-conserving therapy.
BRA: breast retraction assessment.
BSI: breast symmetry index.
CT: computed tomography.
HDR-BT: high dose rate brachytherapy.
ICC: intra-class correlation coefficient.
MRI: magnetic resonance imaging.
NA: non-applicable.
OBCS: objective breast cosmesis Scale.
SSN: suprasternal notch.

References


26. PMID: 17420117.
