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The PRS Rainbow Classification for Assessing Postbariatric Contour Deformities

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Background: There is a need for a reliable classification system to grade contour deformities and to inform reimbursement of body contouring surgery after massive weight loss. We developed the PRS Rainbow Classification, which uses select photographs to provide standardized references for evaluating patient photographs, to classify contour deformities in postbariatric patients. To assess the reliability of the PRS Rainbow Classification to classify contour deformities in massive weight loss patients.

Methods: Ten independent experienced plastic surgeons, 7 experienced medical advisors of the healthcare insurance company, and 10 laypersons evaluated 50 photographs per anatomical region (arms, breast, abdomen, and medial thighs). Each participant rated the patient photographs on a scale of 1–3 in an online survey. The inter-observer and the intra-observer reliabilities were determined using intra-class correlation coefficients (ICCs). The ICC analyses were performed for each anatomical region.

Results: Inter-observer reliability was moderate to good in the body regions "arms," "abdomen," "medial thighs," with mean ICC values of 0.678 [95% confidence interval (CI), 0.591–0.768], 0.685 (95% CI, 0.599–0.773), and 0.658 (95% CI, 0.569–0.751), respectively. Inter-observer reliability was comparable within the 3 different professional groups. Intra-observer reliability (test–retest reliability) was moderate to good, with a mean overall ICC value of 0.723 (95% CI, 0.572–0.874) for all groups and all 4 body regions.

Conclusions: The moderate to good reliability found in this study validates the use of the PRS Rainbow Classification as a reproducible and reliable classification system to assess contour deformities after massive weight loss. It holds promise as a key part of instruments to classify body contour deformities and to assess reimbursement of body contouring surgery. *(Plast Reconstr Surg Glob Open 2020;8:e2874; doi: 10.1097/GOX.0000000000002874; Published online 24 June 2020.)*

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INTRODUCTION

Severe obesity is on the rise in most countries, and bariatric surgery is considered to be the most effective weight loss option.[1–3] The subsequent massive weight loss, however, generally leaves patients with excess skin and a significant abnormal body contour. After bariatric surgery, 80%–90% of the patients described problems with excess skin.[4–8] The excess skin can cause health and hygiene issues, which may lead to significant impairment of the activities of daily living, as well as severe psychologic problems due to disfigurement.[5,6,9–18] Body contouring surgery (BCS) can be used to address these problems of redundant excess skin.[19–21] BCS holds promise for significant improvement of health-related quality of life and better weight control after bariatric surgery.[20–31] Studies reported that 62%–90% of the postbariatric patients desired additional

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reconstructive surgery.[4,6,8,32–36] Due to the increasing number of people undergoing bariatric surgery, the number of postbariatric body contouring procedures performed annually continues to increase.[37–39]

A standardized classification system for body contour deformities is warranted for surgical planning and outcome analysis of postbariatric body contouring procedures, as well as to inform reimbursement. The Pittsburgh Rating Scale (PRS) was the first validated classification system for contour deformities after massive weight loss.[40] In the Netherlands, the PRS is also used for the classification of excess skin, which is one of the criteria for reimbursement by health insurers.[34,41] Although the PRS represents a useful starting point to inform reimbursement for body contouring surgery, a study by van der Beek et al[41] demonstrated that the PRS did not yet show enough evidence of reliability for this purpose. It is likely that contour deformities were visually assessed without the presence of reference photographs of the PRS, making these assessments more biased by each individual interpretation.

The Rainbow Scale is an online system consisting of reference photographs of the deformity to be assessed, and using the scale has shown to be a reliable way for plastic surgeons to evaluate nasolabial fold severity and breast ptosis.[42,43] We developed the PRS Rainbow Classification, which builds on the concepts and the work of the PRS and the Rainbow scale. In the PRS Rainbow Classification, the patient photographs were placed in the center for review and classified against the select photographs from the original PRS to provide standardized references. The purpose of this study was to evaluate the reliability of this newly developed PRS Rainbow Classification. The present study examined whether the classification of contour deformities were the same when assessed by different persons and different stakeholders (ie, plastic surgeons, medical advisors of the healthcare insurance company, and laypersons) (inter-observer reliability) and by the same persons at a different moment in time (intra-observer reliability).

METHODS

Between June 2018 and March 2019, 10 independent experienced plastic surgeons, 7 independent experienced medical advisors of the healthcare insurance company, and 10 independent laypersons were asked to rate the photographs. Each of them rated 50 anterior–posterior photographs of different grades of deformities per deformity region (arms, breast, abdomen, and medial thighs) against the most appropriate corresponding grade. For intra-observer reliability (test–retest reliability), the photographs were randomly displayed in a different order, with a time interval of at least 2 weeks. Patients signed informed consent before BCS for the use of photographs for both medical and scientific purposes. The photographs are anonymized when used for scientific purposes; therefore, no individual patient data were available (ie, medical history and surgical history) in this study. The Institutional Medical Ethics Committee approved this study.

Photography

Standardized preoperative patient photographs are required by the Dutch healthcare insurers in order for reimbursement of BCS and, therefore, are part of the preoperative evaluation of BCS.[44–46] The photographs were selected from the Department of Medical Photography of the UMCG, Groningen, and from the Catharina Hospital, Eindhoven. Once the most adequate photographs were obtained, Adobe Photoshop CC 2018 19.1.5.61161 (Adobe Systems Inc., San Jose, Calif.) was used to further anonymize the photographs for this study by not displaying the faces of the patients.

The PRS Rainbow Classification

The method of van der Beek et al[41] was used as a starting point of this study, and we built on it by adding the Rainbow Scale, a classification system called the PRS Rainbow Classification. The PRS includes 10 regions with a 4-point grading system per anatomical region to systematically describe the common deformities in each region of the body.[40] Each anatomical region is scored ranging from 0 (indicating normal appearance) to 3 (indicating the most severe deformity). The Rainbow Scale method has been adapted from the Merz Scales (Merz Pharmaceuticals GmbH, Frankfurt, Germany). The format of the Rainbow Scale has been previously used in nasolabial fold severity and in grading breast ptosis,[42,43] in which 5 photographs are presented in a rainbow arch with increasing severity. An adapted version was created in the PRS Rainbow Classification by combining the best of both classification systems. Only photographs with grades 1–3 according to the PRS were used as standardized reference photographs in the PRS Rainbow Classification. The patient photograph to be reviewed was placed at the center position, which is surrounded by these 3 standardized photographs. The deformity severity of these standardized reference photographs are placed in increasing order while following the rainbow. The PRS Rainbow Classifications are shown in the **Supplemental Digital Content 1**. (**See figures, Supplemental Digital Content 1**, which display the PRS Rainbow Classification of each anatomical region. The photograph of the patient is located at the center of the lower row. Three grades of the PRS are placed around progressively as a rainbow. The photographs are reproduced from Song et al.[40] **http://links.lww.com/PRSGO/B397**.)

Data Collection

An online survey was created using Castor EDC (Castor Electronic Data Capture, Ciwit BV, Amsterdam, The Netherlands, 2018).

Statistical Analysis

Power analysis showed that a minimum of 42 photographs were necessary for 10 observers to provide a 95% CI of ±0.1 for an estimated intra-class correlation coefficient (ICC) of 0.7. Therefore, we decided to include 50 photographs per observer and per deformity region. The inter-observer agreement was determined using ICC ± 95% CI using a 2-way random-effects model for

Table 1. Overall Inter-observer Reliability

	Overall Intra-class Correlation	95% Confidence Interval	Test 1 Intra-class Correlation	95% Confidence Interval	Test 2 Intra-class Correlation	95% Confidence Interval
Arms	0.678	0.590–0.768	0.686	0.598–0.776	0.659	0.567–0.754
Breasts	0.368	0.284–0.480	0.372	0.283–0.487	0.362	0.272–0.479
Abdomen	0.685	0.599–0.773	0.672	0.582–0.764	0.698	0.610–0.785
Medial thighs	0.658	0.569–0.751	0.664	0.572–0.758	0.665	0.573–0.759

Table 2. Inter-observer Reliability within the 3 Different Professional Groups

	Plastic Surgeons			Medical Advisors of the Insurance Company			Laypersons		
	Overall ICC (95% CI)	Test 1 ICC (95% CI)	Test 2 ICC (95% CI)	Overall ICC (95% CI)	Test 1 ICC (95% CI)	Test 2 ICC (95% CI)	Overall ICC (95% CI)	Test 1 ICC (95% CI)	Test 2 ICC (95% CI)
Arms	0.701 (0.613–0.789)	0.714 (0.621–0.802)	0.664 (0.563–0.762)	0.631 (0.526–0.737)	0.636 (0.518–0.747)	0.558 (0.404–0.697)	0.730 (0.648–0.811)	0.741 (0.655–0.821)	0.711 (0.620–0.799)
Breasts	0.367 (0.274–0.486)	0.372 (0.263–0.504)	0.352 (0.248–0.480)	0.487 (0.381–0.608)	0.504 (0.388–0.630)	0.445 (0.285–0.603)	0.391 (0.298–0.509)	0.367 (0.264–0.495)	0.393 (0.289–0.520)
Abdomen	0.775 (0.702–0.845)	0.763 (0.683–0.837)	0.779 (0.701–0.850)	0.714 (0.623–0.800)	0.683 (0.577–0.781)	0.718 (0.607–0.813)	0.670 (0.580–0.762)	0.647 (0.548–0.748)	0.702 (0.611–0.791)
Medial thighs	0.678 (0.586–0.770)	0.674 (0.571–0.772)	0.704 (0.612–0.792)	0.744 (0.654–0.825)	0.738 (0.639–0.825)	0.723 (0.585–0.826)	0.646 (0.553–0.743)	0.653 (0.553–0.752)	0.645 (0.543–0.747)

single measurement and absolute agreement. The intra-observer agreement (test–retest reliability) was determined using ICC ± 95% CI using a 2-way mixed-effects model for single measurement and absolute agreement. The ICC will be performed for each anatomical region. The ICC takes values in the range of 0 (no agreement) to 1 (perfect agreement). Consistent with the guideline of reporting ICC values for reliability studies, we considered ICC values <0.5 as "poor" reliability, values between 0.5 and 0.75 as "moderate" reliability, values between 0.75 and 0.9 as "good" reliability, and values >0.90 as "excellent" reliability.[47] A high ICC means that the total variance within the data is rather explained by differences between individuals than by that between the observers. All data were analyzed using SPSS 21.0 for Windows (SPSS Inc., Chicago, Ill.).

RESULTS

A total of 200 patient photographs (50 photographs of 4 deformity region: arms, breast, abdomen, and medial thighs) were included in the present study. All photographs of the breast, medial thighs, and arms were from women and 37 photographs of the abdomen were from women (74%).

Inter-observer Reliability

The PRS Rainbow Classification demonstrated a moderate to good inter-observer reliability in the body regions such as arms, abdomen, and medial thighs, with mean ICC values of 0.678 (95% CI, 0.591–0.768), 0.685 (95% CI, 0.599–0.773), and 0.658 (95% CI, 0.569–0.751), respectively (Table 1). The inter-observer reliability in the breasts was poor, with a mean ICC value of 0.368 (95% CI, 0.284–0.480) (Table 1). The mean ICC values of inter-observer reliability were comparable for the first and second test. In all different professional groups, moderate to good ICC values were seen in arms, abdomen, and medial thighs and poor to moderate ICC values in breasts (Table 2).

Intra-observer Reliability (Test–Retest Reliability)

Ten plastic surgeons, 10 lay persons, and 4 medical advisors of the healthcare insurance company completed the second survey for intra-observer reliability (test–retest reliability). Intra-observer reliability per individual is available in the **Supplemental Digital Content 2**. (**See table, Supplemental Digital Content 2**, which displays intra-observer (test–retest) reliability per individual by professional groups (plastic surgeons, medical advisors of the healthcare insurance company, and laypersons), **http://links.lww.com/PRSGO/B398**.) Intra-observer reliability (test–retest reliability) was moderate to good, with a mean overall ICC value of 0.723 (95% CI, 0.572–0.874) for all professional groups and for all 4 body regions (Table 3). The intra-observer reliability for each single anatomical region was good in arms, abdomen, and medial thighs, with mean ICC values of 0.779 (95% CI, 0.662–0.896), 0.787 (95% CI, 0.689–0.885), and 0.755 (95% CI, 0.649–0.861), respectively. The intra-observer reliability of the breasts was poor, with a mean ICC value of 0.570 (95% CI, 0.407–0.734).The mean ICC values in the different groups (plastic surgeons, medical advisors of the healthcare insurance company, and laypersons) were 0.721

Table 3. Intra-observer (Test–Retest) Reliability by Professional Group

	Mean ICC		
	Plastic Surgeons	Medical Advisors of the Insurance Company	Laypersons
Arms	0.765	0.842	0.767
Breasts	0.557	0.649	0.552
Abdomen	0.819	0.842	0.734
Medial thighs	0.743	0.871	0.720

(95% CI, 0.578–0.864), 0.801(95% CI, 0.673–0.929) and 0.693 (95% CI, 0.534–0.852), respectively.

DISCUSSION

The present study demonstrates that the PRS Rainbow Classification is a reliable tool for the classification of contour deformities in postbariatric patients with a desire for BCS. In the arms, abdomen, and medial thighs, there was moderate to good inter-observer and intra-observer reliability, indicating that plastic surgeons, laypersons, and medical advisors of the healthcare insurance company rated photographs similarly. Intra-observer reliability was good in arms, abdomen, and medial thighs for all raters, which means that individuals consistently rated the photographs. In arms, abdomen, and medial thighs, the PRS Rainbow Classification showed higher ICC values compared with the breasts, which describes that the classification of the photographs pertaining to these body regions was more consistent across different persons and within the same person compared with those related to breasts.

An objective and easy-to-use tool is not only essential for reliable classification of contour deformities, but also to select those patients who may qualify for BCS reimbursement. Patient access to body contouring procedures following bariatric surgery is limited due to the lack of personal financial resources, and therefore patients primarily rely on their healthcare insurer.[34,48–57] Many insurance policies, however, currently use the length of overhanging skin as an objective means of quantifying excess loose skin deformities, which is not a reliable measure.[51,52,58,59] Researchers from several countries have raised the issue of unclear reimbursement.[34,48–53,59–61] Originally, the PRS was designed to describe preoperative deformities in a standardized manner. It was never intended as a tool for insurance companies to determine whether or not the deformity is reimbursed for BCS.[40] In clinical practice, a significant discrepancy exists between the PRS assessment by plastic surgeons or medical advisors of the healthcare insurance company. This probably also reflects the different viewpoints and concerns of both professionals (ie, plastic surgeon serving patients and getting work; insurance companies limiting costs) and emphasizes the need for a better classification tool to decide which patients should be reimbursed. The PRS Rainbow Classification, as evaluated in this study, is a classification tool that results in reliable scoring across different stakeholder groups. The comparable rating scores of the postbariatric patient photographs among and within plastic surgeons, medical advisors of the healthcare insurance company, and laypersons indicated that the PRS Rainbow Classification is a reliable classification system for different purposes.

Only in the breasts, the PRS Rainbow Classification demonstrated poor inter-observer and intra-observer reliabilities. We hypothesize that this difference is due to the variability in breast deformities after massive weight loss. Breast deformities vary more significantly compared with deformities of other body regions.[62] Postbariatric patients present with a wide range of different breast deformities, different breast volumes, and additional deformities (ie, nipples deformities or lateral chest rolls) that are not adequately described with the 3 deformity scales of anterior–posterior photographs presented in the original PRS. For better classification of breast deformities, the PRS Rainbow Classification should be further enhanced using different views (eg, oblique and lateral views). Furthermore, the steps between the different grades of breast deformities vary more significantly compared with the steps between the different grades of other body regions. The PRS Rainbow Classification could be further improved with computer-simulated photography of one person to avoid inevitable differences in photographs of different persons as seen in the original PRS and in this PRS Rainbow Classification. A specific increase in the length of overhang per anatomical region will be incorporated into the photographs with image morphing techniques to create a representative grading classification with equal steps between the grades. This equal stepwise variation of morphed photographs used in a classification scale has already been shown to be reliable in the Merz Scales (Merz Pharmaceuticals GmbH, Frankfurt, Germany). Moreover, image morphing techniques will allow for additional improvements in the photographs (eg, knees are not visible on the PRS photographs of the abdomen, even though this is an essential point of reference in the judgment of excessive skin of the abdomen). These next steps will be undertaken to further improve the PRS Rainbow Classification.

A limitation in the use of the PRS Rainbow Classification is the lack of anthropometry. On the other hand, not using anthropometry makes the PRS Rainbow Classification a quick and straightforward tool for use in daily practice. Another limitation of this study is that the PRS Rainbow Classification was only tested for the indication of body contouring procedures. Moreover, while excess loose skin can be functionally and psychologically bothersome, these issues are not incorporated in the current PRS Rainbow Classification. Excess loose skin may hamper the health-related quality of life of patients and can lead to medical complaints, and body contouring procedures (ie, abdominoplasty, lower body lift, upper body lift) are the only effective treatments to remove excess skin.[5,6,9–21] Not only should all these aspects be evaluated when selecting patients to qualify for BCS reimbursement, but the factors that can affect the development of excess skin, such as preoperative ptosis, body mass index, and circumference, have to be considered too.[55,58,63] The PRS Rainbow Classification should be used as an objective tool for classifying excess loose skin in addition to the screening tools that take into account medical, psychological, and physical complaints, as well as the predictors of excess skin (eg, the Dutch Reboc tool) to justify insurance coverage.[64] A pilot study combining the improved version of the PRS Rainbow Classification and the Dutch Reboc Scale is currently underway.

CONCLUSIONS

The moderate to good reliability found in this study validates the use of the PRS Rainbow Classification, which uses select photographs from the original PRS to

provide standardized references for evaluating patient photographs, as a reproducible and reliable classification system to assess body contour deformities after massive weight loss. This classification system holds promise as a key part of instruments to classify body contour deformities and to assess reimbursement of BCS and should be further improved, especially for the breast deformities.

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