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The Rainbow Scale for Assessing Breast Ptosis: Validation of Three Different Views

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Abstract

Background: Photographic scales have become an increasingly used tool in objectively assessing outcomes in aesthetic surgery. However, no online photographic scale for assessing breast ptosis has been developed yet that is readily available.

Objectives: This study was designed to validate the online Rainbow Scale for the assessment of breast ptosis for the anterior-posterior (AP), lateral, and oblique views.

Methods: For the five grades of the Rainbow Scale format, standardized reference photographs were selected. Six plastic surgeons rated 15 photographs for each view three times. Intra- and inter-observer agreements were calculated by using the weighted kappa coefficient and differences in intra- and inter-observer agreements between the three views were assessed for statistical significance using the Kruskal-Wallis test.

Results: The mean intra-observer agreements were 0.91 (range, 0.82-0.98) for the AP view, 0.88 (range, 0.77-1.00) for the oblique view, and 0.86 (range, 0.74-0.97) for the lateral view and did not vary significantly between all three views. The mean inter-observer agreements were 0.88 (range, 0.77-0.95) for the AP view, 0.84 (range, 0.72-0.94) for the oblique view, and 0.82 (range, 0.58-0.95) for the lateral view. The mean inter-observer agreements of the AP view varied significantly from the oblique view (P = .012) and the lateral view (P = .001).

Conclusions: The Rainbow Scale for breast ptosis has been validated for the AP view, the lateral view, and the oblique view and is reproducible and reliable for the assessment of breast ptosis in three different views in an online setup.

Level of Evidence: 4

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Photographic scales have become an increasingly used tool in objectively assessing outcomes in aesthetic surgery. The growing number of such scales affects homogeneity of outcome measures and leads to discrepancies between results.[1]

The Rainbow Scale, created by van Dongen et al, is a previously validated photographic assessment tool that is used to grade the severity of a deformity in a homogeneous way by comparing a photograph against an array of photographs arranged with increasing severity.[2] It proved to be a reliable and objective measurement that can be performed in an easy online fashion. The Rainbow Scale has previously been validated to grade nasolabial fold severity, but never has been validated to grade breast ptosis.

Regarding breast ptosis several classifications can be used, of which Regnault's classification has been the standard.[3-6] These classifications are either non-photographic descriptions of breast ptosis, or use complex anthropometric measures to

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grade breast ptosis on clinical photographs. Moreover, no photographic scales have been developed yet for assessing breast ptosis in an easy access online setup. Considering this, there is a clear need for a uniform standardized photographic scale for assessing breast ptosis that is easy to use and readily available in an online fashion.

Breast ptosis can be evaluated in anterior-posterior (AP), oblique, and lateral views. Hence, the objective in this study is to validate these three different views for the assessment of breast ptosis using the versatile and online Rainbow Scale format. There is no consensus regarding the best view for assessing breast ptosis. Therefore, we additionally sought to investigate any differences between the reproducibility of these three different views for breast ptosis assessment.

METHODS

Photographic Editing and Equipment

For the three views of the breast (AP, right lateral, and right oblique) 15 high-resolution standardized photographs of female subjects with different degrees of breast ptosis were included in this study. All photographs were digitally taken with a Nikon mirror reflex D3100 camera (Nikon Corporation, Tokyo, Japan) with a Nikon DX - AF-S Nikkor 18 to 55 mm (1:3.5-5.6G) lens. A total of 45 photographs were standardized in Adobe Photoshop CS6 Version 13.0 × 64 (Adobe Systems Inc., San Jose, CA) by correcting the background, alignment, skin color and contrast and brightness to be equal.

Identification of Reference Photographs

The Rainbow Scale format consists of five reference photographs.[2] For the Rainbow Scale for breast ptosis the grades were described as: Grade 1 (no breast ptosis): thoracomammary angle $>90°$, no visible breast ptosis; Grade 2 (mild breast ptosis): thoracomammary angle $<90°$, but the nipple lies still above the level of the inframammary fold; Grade 3 (moderate breast ptosis): the nipple lies at the level of the inframammary fold, above the inferior breast contour; Grade 4 (severe breast ptosis): the nipple lies below the level of the inframammary fold but remains above the inferior breast contour; and Grade 5 (extreme breast ptosis): the nipple lies below the level of the inframammary fold and at the inferior breast contour. The description of Grades 3, 4, and 5 are based on Regnault's classification.[3]

Preoperative photographs from breast surgery cases taken between January 2010 and January 2015 that corresponded to the description of the five grades of the Rainbow Scale for breast ptosis were selected from the senior authors' (HPS) database. To select the reference photographs, a three-step selection with a minimal interval of one day between the steps was performed by the lead author (BME) and the senior author (HPS). Firstly, for the AP view, the lateral view and the oblique view, respectively 35, 40, and 30 preoperative photographs with different degrees of breast ptosis were selected. Photographs were excluded if breasts were asymmetrical, if photographs were not taken from the right angle and if the quality of the photograph was too low for further standardization. Secondly, a set of 15 photographs for each view was selected, containing three potential reference photographs that corresponded best to each grade on the Rainbow Scale. These three sets of 15 photographs were then standardized. Finally, the best five representative photographs out of the set of 15 photographs were identified. The models in the photographs of the final selection had a mean age of 41 years (range, 26-51 years) and a mean BMI of 23.8 kg/m^2 (range, 19.3-28.1 kg/m^2). For each view a Rainbow Scale was created (Figures 1-3). The study was conducted in accordance with the Declaration of Helsinki.

Online Validation of the Rainbow Scale for Breast Ptosis

An online survey was created by the lead author (BME) in SurveyMonkey (SurveyMonkey, Palo Alto, CA) for the validation of the Rainbow Scale for assessing breast ptosis. Each question in the survey was a one-page representation of the Rainbow Scale with a photograph for assessment in the free spot in the bottom center. These photographs were newly selected preoperative and postoperative photographs from the senior author's database. Each grade on the Rainbow Scale was represented by three questions. Hence, the survey contained 15 questions per view with a total of 45 questions. An introduction page was added to the survey, containing descriptive information of grades of the Rainbow Scale for breast ptosis. A blank copy of the survey is available as Supplementary Material at www.aestheticsurgeryjournal.com.

Between November 2015 and May 2016, six independent experienced plastic surgeons rated the photographs in the free spot according to the appropriate corresponding grade on the Rainbow Scale (Table 1). Five independent surgeon panelists were Dutch Association for Facial, Plastic, and Reconstructive Surgery (DAFPRS) fellows that have previously visited the senior author (HPS) for a fellowship and one independent surgeon panelist was a colleague of the senior author. The panelists did not know any of the human subjects used in the reference photographs or survey questions and have not been involved with the human subjects in this study. Neither did they know whether the photographs were preoperative or postoperative. The panelists independently completed the survey three times with a minimum interval of two days. Each time the questions were presented in a random sequence. Computer randomization was performed with Microsoft Excel Version 14.4.9. (Microsoft, Redmond, WA). For each panelist the intra-observer agreement was calculated based on the comparison of the three completed surveys (first vs second, first vs third, and second vs third). Inter-observer agreement

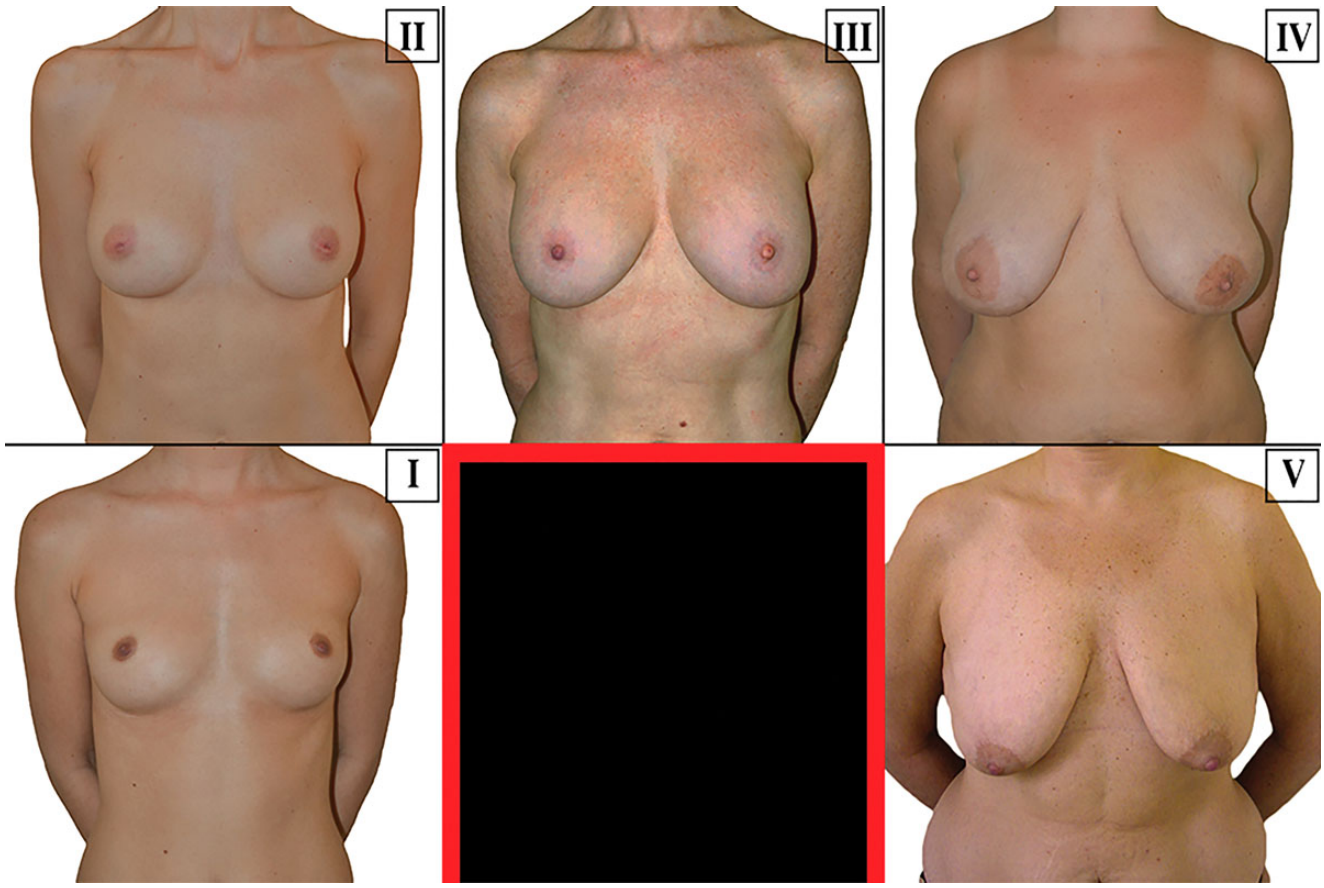

Figure 1. The Rainbow Scale for anterior-posterior assessment of breast ptosis. The photograph of the patient is located in the central position of the lower row. Five grades of the breast ptosis assessment scale are placed around progressively as a rainbow as demonstrated on a 26-year-old female subject (I), a 38-year-old female subject (II), a 50-year-old female subject (III), a 49-year-old female subject (IV), and a 45-year-old female subject (V).

was calculated to determine agreement between pairs of panelists in the three completed surveys.

Statistical Analysis

To determine the intra-observer and inter-observer agreement the weighted kappa coefficient was used in SPSS version 21.0.0.1 (IBM, New York, NY).[7]

Differences in mean intra- and inter-observer agreements between the three views were assessed for statistical significance using the Kruskal-Wallis test in GraphPad Prism 6.0 (GraphPad, San Diego, CA). The post hoc Dunn's test was used for multiple comparisons. The significance level was $P < .050$.

RESULTS

Online Validation of the Rainbow Scale for Breast Ptosis

The mean intra-observer agreements were 0.91 (range, 0.82-0.98) for the AP view, 0.88 (range, 0.77-1.00) for the oblique view, and 0.86 (range, 0.74-0.97) for the lateral view (Table 2). The means of intra-observer agreements did not vary significantly between all three views ($P = .350$).

The mean inter-observer agreements within pairs of plastic surgeons were 0.88 (range, 0.77-0.95) for the AP view, 0.84 (range, 0.72-0.94) for the oblique view, and 0.82 (range, 0.58-0.95) for the lateral view (Table 3).

The mean of the inter-observer agreements of the AP view is significantly higher than the oblique view ($P = .012$) and the lateral view ($P = .001$). The mean of the inter-observer agreements of the oblique view and the lateral view did not vary significantly ($P > .999$).

DISCUSSION

In this study the Rainbow Scale for breast ptosis based on the Rainbow Scale format by van Dongen et al has been validated as a result of good intra- and inter-observer agreements for the AP view, the oblique view, and the lateral view.[2] This scale is reproducible and reliable for the assessment of breast ptosis in three different views in an online

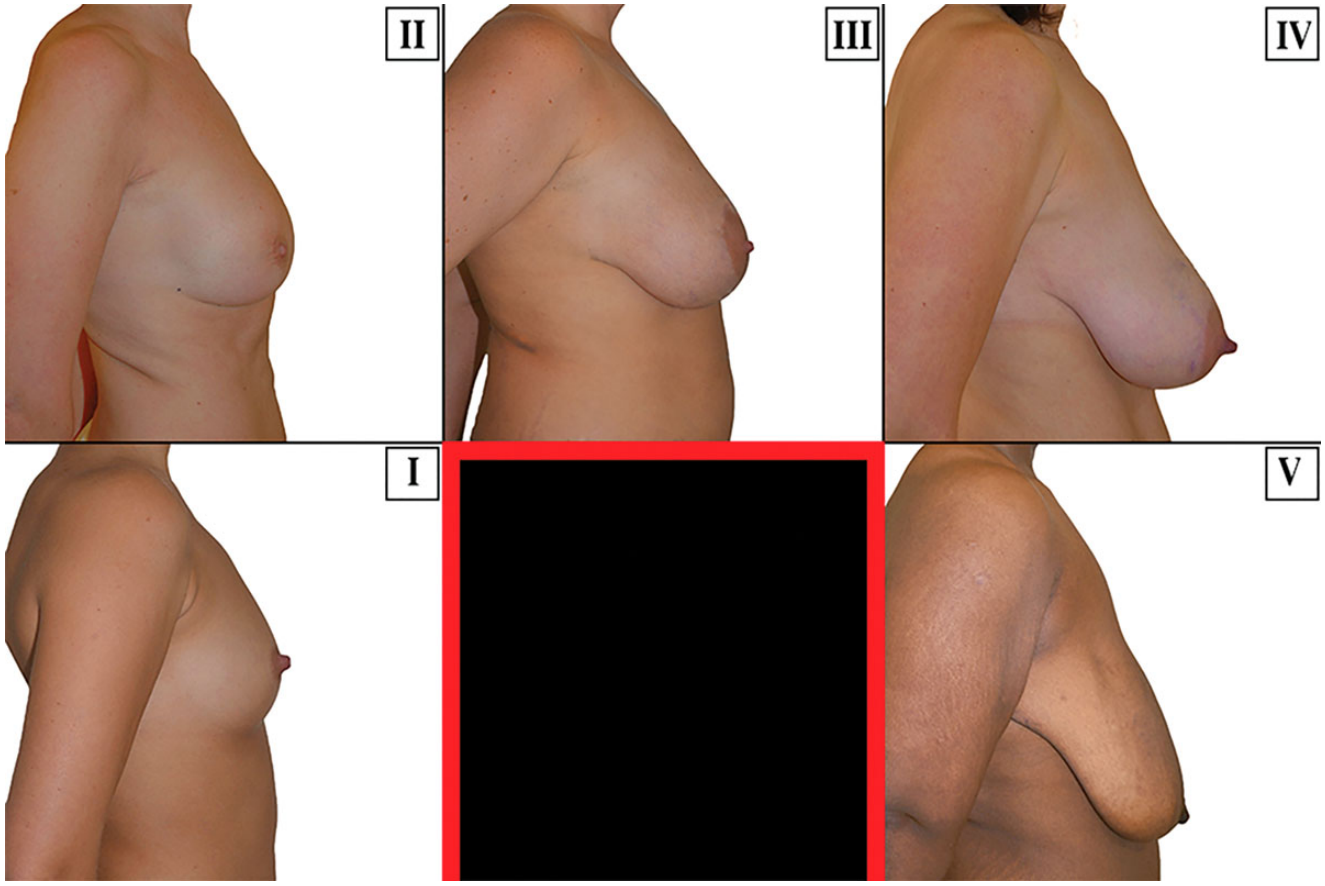

Figure 2. The Rainbow Scale for lateral assessment of breast ptosis. The photograph of the patient is located in the central position of the lower row. Five grades of the breast ptosis assessment scale are placed around progressively as a rainbow as demonstrated on a 34-year-old female subject (I), a 51-year-old female subject (II), a 50-year-old female subject (III), a 40-year-old female subject (IV), and a 44-year-old female subject (V).

setup. It is a simple and practical method for evaluating breast ptosis that modernizes the classical modes of grading breast ptosis in line with current digital recordkeeping.

Since surgical evaluation with clinical photographs after breast lift surgery is mostly done in AP, oblique, and lateral views, the Rainbow Scale has been validated for all three views. Classic lateral assessment gives the opportunity to assess both breasts individually. AP assessment can be useful to evaluate intra-patient breast asymmetry. By using the oblique view, both breasts can be assessed from a different angle. In our data, slight differences between the three different views were observed. Both intra- and inter-observer agreements were the highest for the AP view, followed by the oblique view. The conventional lateral view showed the lowest intra- and inter-observer observer agreements. Significance was reached for the difference in mean inter-observer agreements between the AP and the lateral view and between the AP and the oblique view, indicating that there is more consensus for using the AP view than the oblique and lateral views. All other means of intra- and inter-observer agreements between the three views did not vary significantly. Although the AP view is of major importance, breasts are optimally evaluated in all three views. For the AP, lateral, and oblique views, the mean intra- and inter-observer agreement values were high. We therefore suggest that evaluation of breast ptosis and breast lift surgery is performed by using all three views of the Rainbow Scale, supporting the current standard in clinical practice.

The selection of the reference photographs for each view was based on the quality and suitability of the photographs, not on similarity with other views. Hence, reference photographs for one grade vary between different views. Inevitable differences in live model positioning, body type, skin color and character, and breast and nipple size and shape, that result from each grade being illustrated by a different live model, could potentially be distracting and obscure rather than clarify the grading scale. Obviously, artist drawings or written classifications could have been used instead of live models. However, we sought to develop a grading scale that is, reproducible, reliable, easy to use and in line with modern

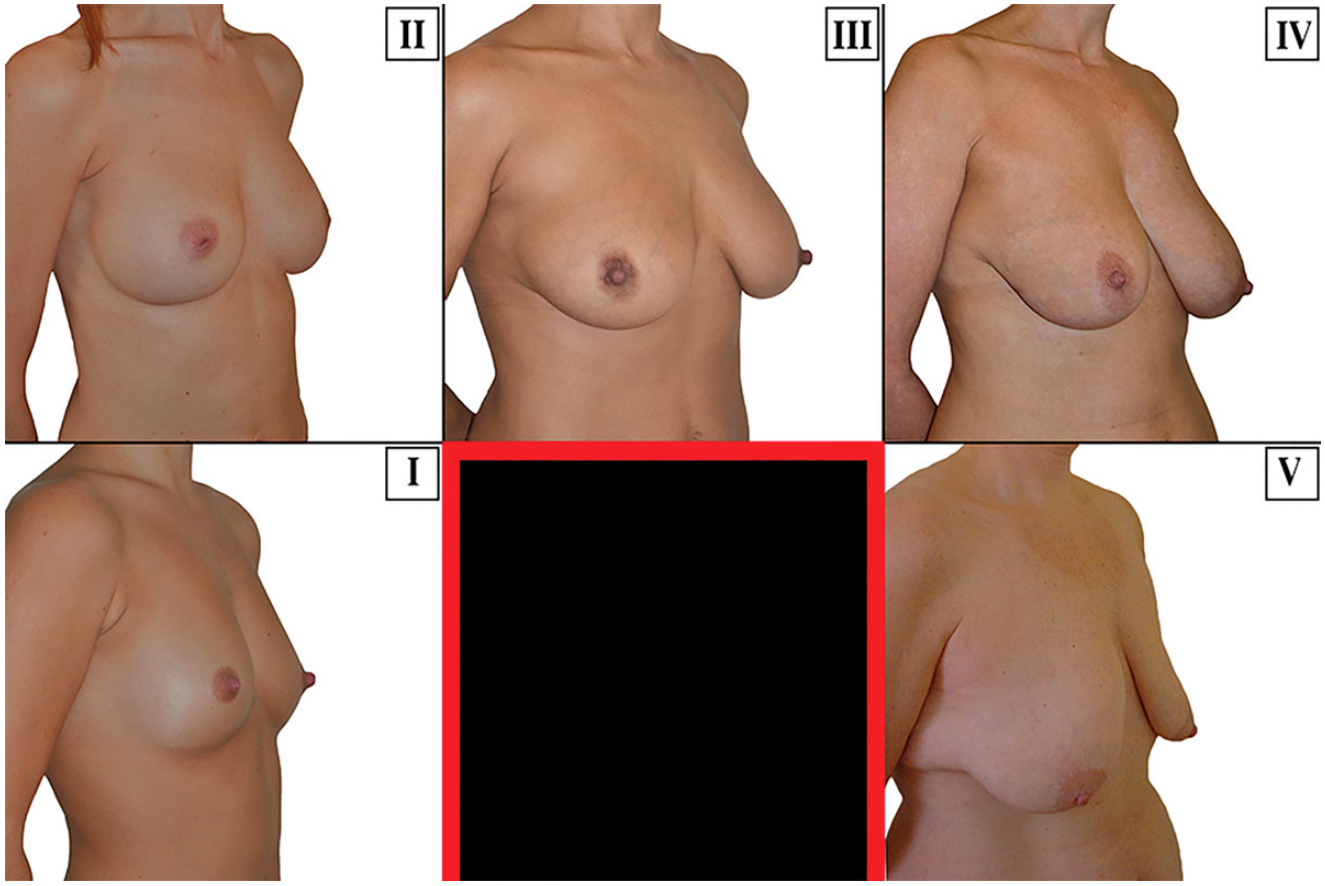

Figure 3. The Rainbow Scale for oblique assessment of breast ptosis. The photograph of the patient is located in the central position of the lower row. Five grades of the breast ptosis assessment scale are placed around progressively as a rainbow as demonstrated on a 34-year-old female subject (I), a 38-year-old female subject (II), a 43-year-old female subject (III), a 31-year-old female subject (IV), and a 45-year-old female subject (V).

Table 1. Demographic Information of the Panelists

	Panelists ($n = 6$)
Male : Female	5 : 1
Mean age, years (range)	36.7 (30-41)
Mean experience time, years (range)	9.3 (5-15)

ways of documentation. Interestingly, using digitally standardized photographs of different models provided high consensus rates and statistical significance in each view. Accordingly, this study shows that regardless of slight differences in skin color, skin texture and even positioning, the scales have proven to be highly reliable and reproducible. In addition, by using live models the Rainbow Scale is a much more realistic way to score degree of breast ptosis and is in line with modern ways of documentation.

The Rainbow Scale does not use any anthropometry. Therefore, no training is needed to evaluate breast lift surgery, which makes the scale very easy to use. Moreover, preoperative and postoperative differences and treatment outcome can easily become clear for the patient as well. By using the Rainbow Scale format, aesthetic outcomes are assessed in an online fashion. It can therefore be accessed faster and more easily and data can be directly translated into other computer programs, reducing the risk of loss of information.[2]

Photographic documentation has become an important advance in aesthetic plastic surgery for scientific and clinical purpose.[8] Also for evaluating breast lift surgery in an objective way, photographic evaluation has become a standard. Regnault's and Kirwan's classifications are both non-photographic descriptions of breast ptosis, impeding direct and easy photographic assessment. In contrast, Kim et al used clinical photographs to determine ratios of distances between manually identified fiducial points.[4] Their use of anthropometry arose from dissatisfaction with previous photographic assessment methods of aesthetics with low intra- and inter-observer agreements. Although anthropometry can be useful, direct measurements have limitations regarding both the routine clinical practice and the evaluation procedure. A

clear difference between experienced clinical observers and novice observers was observed in their research, suggesting the high degree of difficulty of their method.

Over the years, several breast ptosis classifications have been developed. Regnault classified breast ptosis at first into three distinct grades and pseudo ptosis using the position of the nipple in relation to the infra-mammary fold.[3] Regnault's classification has been the standard ever since. Additionally, measurements from the nipple to the inframammary fold can be added to this classification to specify the grade of breast ptosis.[6] Regnault's classification is a non-photographic description of breast ptosis, which prioritizes nipple ptosis over glandular ptosis. According to Regnault, the end point of ptosis is reached when the nipple descends below the inframammary fold and lies at the inferior breast contour. Given that tubular breast deformity and its lesser manifestations can express similar anatomic characteristics, its application to breast lift surgery can be difficult.[9] Consequently, Kirwan proposed a more elaborate staging system consisting of six grades that classifies breast ptosis in 1 cm stages.[5] The author argued the advantages of his classification compared to Regnault's classification for surgical planning, as he suggested surgical strategies for each stage of breast ptosis. Also, Kirwan did not include any separate breast shape stages because of the irrelevance for decision-making processes. Despite of these remarks, Regnault's classification has been considered as standard for staging breast ptosis and has been continuously used in clinical practice. The descriptive information to improve our validation process, was therefore based on Regnault's classification.

We did not compare our method of ptosis grading with the traditional Regnault scale. Our goal was to provide a modernized online alternative that can be used directly with clinical photographs. In addition to Regnault's we added Grade 1: no breast ptosis (thoracomammary angle $>90°$, no

Table 2. Intra-observer Agreements for the AP, Oblique, and Lateral Views Expressed as Weighted Kappa Coefficient

	AP View Mean (range)	Oblique View Mean (range)	Lateral View Mean (range)
Plastic surgeon 1	0.93 (0.91-0.95)	0.96 (0.94-0.98)	0.94 (0.92-0.97)
Plastic surgeon 2	0.93 (0.90-0.94)	0.84 (0.81-0.86)	0.85 (0.80-0.93)
Plastic surgeon 3	0.96 (0.95-0.98)	0.89 (0.86-0.91)	0.91 (0.88-0.93)
Plastic surgeon 4	0.90 (0.86-0.93)	0.90 (0.89-0.90)	0.83 (0.74-0.91)
Plastic surgeon 5	0.85 (0.82-0.88)	0.90 (0.85-1.00)	0.85 (0.79-0.90)
Plastic surgeon 6	0.89 (0.83-0.94)	0.81 (0.77-0.83)	0.81 (0.76-0.92)

Values are the mean (range) of the weighted kappa coefficients that were calculated by the comparison of the three completed surveys: first vs second, first vs third and second vs third. AP, anterior-posterior.

Table 3. Inter-observer Agreements for the AP, Lateral, and Oblique Views Expressed as Weighted Kappa Coefficient

	AP View Mean (range)	Oblique View Mean (range)	Lateral View Mean (range)
Plastic surgeon 1 vs Plastic surgeon 2	0.92 (0.90-0.95)	0.84 (0.74-0.91)	0.83 (0.79-0.86)
Plastic surgeon 1 vs Plastic surgeon 3	0.93 (0.91-0.95)	0.85 (0.82-0.89)	0.90 (0.88-0.92)
Plastic surgeon 1 vs Plastic surgeon 4	0.91 (0.90-0.92)	0.90 (0.85-0.93)	0.86 (0.79-0.94)
Plastic surgeon 1 vs Plastic surgeon 5	0.87 (0.83-0.91)	0.90 (0.87-0.94)	0.78 (0.75-0.81)
Plastic surgeon 1 vs Plastic surgeon 6	0.84 (0.82-0.86)	0.80 (0.72-0.88)	0.83 (0.76-0.92)
Plastic surgeon 2 vs Plastic surgeon 3	0.92 (0.86-0.95)	0.86 (0.79-0.94)	0.89 (0.84-0.95)
Plastic surgeon 2 vs Plastic surgeon 4	0.92 (0.87-0.94)	0.85 (0.76-0.92)	0.85 (0.83-0.87)
Plastic surgeon 2 vs Plastic surgeon 5	0.86 (0.83-0.88)	0.81 (0.80-0.82)	0.74 (0.64-0.85)
Plastic surgeon 2 vs Plastic surgeon 6	0.84 (0.81-0.87)	0.80 (0.77-0.84)	0.83 (0.72-0.95)
Plastic surgeon 3 vs Plastic surgeon 4	0.91 (0.87-0.94)	0.83 (0.76-0.89)	0.84 (0.78-0.93)
Plastic surgeon 3 vs Plastic surgeon 5	0.90 (0.86-0.91)	0.83 (0.79-0.86)	0.76 (0.67-0.81)
Plastic surgeon 3 vs Plastic surgeon 6	0.85 (0.84-0.86)	0.78 (0.76-0.82)	0.87 (0.75-0.95)
Plastic surgeon 4 vs Plastic surgeon 5	0.83 (0.77-0.86)	0.87 (0.85-0.91)	0.76 (0.71-0.81)
Plastic surgeon 4 vs Plastic surgeon 6	0.85 (0.83-0.88)	0.82 (0.76-0.86)	0.76 (0.59-0.92)
Plastic surgeon 5 vs Plastic surgeon 6	0.93 (0.91-0.94)	0.81 (0.78-0.85)	0.72 (0.58-0.85)

Values are the mean (range) of the weighted kappa coefficients that were calculated between pairs of panelists in the three completed surveys. AP, anterior-posterior.

visible breast ptosis) and Grade 2: mild breast ptosis (thoracomammary angle $< 90°$, but the nipple lies still above the level of the inframammary fold), to score postoperative outcomes as well. Unlike other classifications, this gives the opportunity to not only use the Rainbow Scale for assessing the outcome of breast lift surgery, but also make this scale pertinent to breast enlargement, asymmetry, and deformity.

Breast ptosis is only one of the aspects of breast assessment that are relevant for the decision-making progress. For example, the quality of the soft tissue envelope and the direction that the nipple faces on the breast mound are other factors that can be independent of the grade of ptosis but do alter the decision-making process.[10] Consequently, a limitation of this grading system is that the Rainbow Scale for breast ptosis does not incorporate nipple orientation and angulation, soft tissue envelope, parenchymal characteristics, breast volume, or any other elements than ptosis that are relevant for the decision-making process. However, a further subdivision of the grading system would overcomplicate this simple system. It would reduce its utility and impede the fast and easy assessment of breast ptosis that we aspire with the Rainbow Scale.

Currently, various techniques for correction of breast ptosis are in use. Professionals in surgery should use the three views of the Rainbow Scale with our validated reference photographs to assess breast ptosis and compare changes of preoperative and postoperative breasts. The Rainbow Scale for assessing breast ptosis can in future potentially be implemented in a treatment algorithm to further improve its practical format. Our group is currently using the Rainbow Scale for breast ptosis in the evaluation of two different techniques for correcting breast ptosis. However, the choice of treatment depends on the grade of breast ptosis. Therefore, future research should focus on the Rainbow Scale in clinical practice. The Rainbow Scale can be used for research purposes by, for example, comparing preoperative and postoperative photographs or comparing longevity of different breast lift techniques. Moreover, it is a useful tool in the clinical setting. With this photographic format, it is far simpler to have meaningful discussions with patients about expectations and when comparing preoperative and postoperative photographs.

CONCLUSIONS

The Rainbow Scale for breast ptosis has been validated for the AP view, the lateral view, and the oblique view in an online fashion. The scale is reproducible and reliable for the assessment of breast ptosis in three different views. Except for the higher inter-observer agreements of the AP view compared to the lateral view and the oblique view, no significant variation was observed between the views.

Supplementary Material

This article contains supplementary material located online at www.aestheticsurgeryjournal.com.

Disclosures

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