

The Objective Buttocks Assessment Scale (OBAS): a new and complete method to assess the gluteal region.

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ABSTRACT

Introduction: New treatment methods to improve and enhance buttocks appearance require globally accepted scales for aesthetic research and patient evaluation. The purpose of our study was to develop a set of grading scales for objective assessment of the gluteal region and assess their reliability and validity.

Materials and methods: Twelve photonumeric grading scales were created. Eleven aesthetic experts rated photographs of 650 women in 2 validation sessions. Responses were analyzed to assess inter-rater and intra-rater reliability. The Rasch model was used as part of the validation process.

Results: All the scales exceeded criteria for acceptability, reliability and validity. Overall inter-rater reliability and intra-rater reliability were both “almost perfect” ($p=0.15$ and $p=0.16$ respectively).

Conclusion: Consistent outcomes between raters and by individual raters at 2 time points confirm the reliability of the Objective Buttocks Assessment Scale in female patients and suggest it will be a valuable tool for use in research and clinical practice.

Keywords: Gluteal Assessment Scale, gluteal region, gluteal scale, buttock scale, assessment scale.

Introduction

Buttocks have always been synonymous of femininity and especially nowadays, thanks to the internet, the magazines and the media, the care of our body has become one of the most important aspects of our lives (1). In fact, there has been a sudden increase in the number of patients demanding surgical and non-surgical procedures to improve and enhance the appearance of their buttocks (2-3). For these reasons, several authors started to create evaluation scores for the gluteal region (4). However, a scale that objectively evaluates the totality the buttocks and that can be simple to use and available immediately does not exist yet. We present a new score, more complete and easier to use, to objectively assess the appearance of the buttocks. This is the first study in which the authors have developed and validated a global and objective scale to assess the gluteal region: the Objective Buttocks Assessment Scale (OBAS).

Materials and Methods

We designed a prospective study assessing different characteristics of the gluteal region. The study design was approved by the Ethics Committee of our Institution. Between January 2017 e December 2019, 671 patients were enrolled, informed about the study, and assessed. Patients to be included were chosen by four blinded examiners with different backgrounds: two external board certified dermatologists, and two external board certified plastic surgeons, so that all the degrees in the scale could be included and assessed. 650 women aged 18 to 53, with a BMI (body mass index) ranging from 19.7 to 29.9, were included in the study. Exclusion criteria were: previous buttock surgery or other aesthetic procedure on this area, BMI > 30 and pregnancy. All patients were made aware of the objectives of the study and signed an informed consent. A total of 12 numerical sub-scales were developed and reunited under the name of OBAS. Each sub-scale was set to range from 0 (best gluteal appearance) to 3 (poorest gluteal appearance). The sum of the sub-scales would allow us to obtain a final score ranging from 0 (best score/best and ideal gluteal shape and cutaneous features) to 36 (worst score/gluteal shape and cutaneous features). Bi-dimensional photographs were taken for each patient

with high-resolution photography system by two independent plastic surgeons under the same light conditions and in the same position: patient facing the surgeon, then in a posterior and lateral view. A digital database containing the 650 patients photographs was created. All patients were informed about the study purpose and gave their consent for data analysis and publication. Eleven raters (4 plastic surgeons, 3 dermatologists, 2 nurses, 1 psychologist, and 1 hospital secretary), who took part in the scale validation process, unaware of the criteria of patient selection, were asked to rate the photographs. The scores were printed out and a blank field was left to enter the ratings for the 12 aesthetic subscales. Photographs were shown at the same time and in the same office to the raters using 15 identical computers with the same image settings. The raters were asked to use four items (0-3) and to fill in the blank field next to the sub-scales with the ratings to the studied aesthetic characteristics. Each rater made the assessments independently in every evaluation cycle, assigning a total score derived from the sum of the specific sub-scales. The experts were instructed to assess patients independently and to return the printed scales with their ratings. The entire assessment process lasted three days and was repeated one month later to test the intra-rater consistency of the results. Some cropped images were chosen from the 650 subjects to be paired to the scores at the end of the validation process, based on the studied characteristics, image quality and clarity. Some pictures from the photograph database were selected to represent the different gluteal appearance and were then associated with each numerical score of the 12 subscales [See **Figure, Supplemental Digital Content 1**, which shows a representative example of photometrical rating scales for the skin laxity: absence of skin laxity (a); mild skin laxity (b); moderate skin laxity (c); severe skin laxity (d), [INSERT HYPER LINK HERE](#)]. The photographs were considered eligible to be associated with the scales if at least seven raters had assigned the same rating for a specific sub-scale in each given patient. The evaluation criteria for the construction of the 12 sub-scales (**Table 1**) are listed below and explained in detail:

1. **CUTANEOUS LAXITY GRADE:** This criterion considers the degree of skin laxity, the analysis of the 650 patients examined in our clinic allowed us to identify 4 degrees of increasing severity of laxity or relaxation of the skin and helped us design a score between 0 and 3:

3: severe laxity or relaxation of skin

2: moderate laxity or relaxation of the skin

1: laxity or mild skin relaxation

0: absence of laxity or skin relaxation

2. **NUMBER OF STRETCH MARKS PER BUTTOCK:**

The “striae distensae” (SD) are a very common problem. They evolve through two clinical phases, an early inflammatory phase or phase of the striae rubrae and a chronic phase or phase of the striae albae (5-6). The two types of SDs are included without distinction in our evaluation criteria.

3: more than 20 SD per buttock

2: between 20 and 10 SD per buttock

1: <10 SD

0: absence of SD.

3. **CELLULITE (CLASSIFICATION SCALE BY N ÜRNBERGER AND MÜLLER):**

Cellulite affects millions of women but fewer men. It is considered as lipodystrophy, or rather as a degeneration of the fatty tissue. The changes that occur during the pathogenesis of cellulite are the formation of fibrosis and sclerosis, which appear clinically as indentations of the skin surface and palpable subcutaneous nodules. When the process is advanced, nodules and sclerotic lesions are accompanied by pain, dryness and thinning of the skin that covers the affected area. Cellulite formation accelerates during adolescence, pregnancy or in women

around the age of menopause. It is estimated that up to 85% of women over the age of 20 can be affected by this condition (7).

For this sub-scale, four degrees of clinical presentation of this condition were identified according to the classification of Nürnberger and Müller (8) and were associated to a progressive score from 0 to 3:

3: third degree (presence of stage 2 alterations in greater number and over a larger area, accompanied by nodules and indentations of the skin).

2: second degree (cellulite indentations are present and visible even without stressing the skin)

1: First degree (the affected skin is smooth, but signs of cellulite appear by pinching the skin or contracting the buttocks)

0: No signs of cellulite

4. NUMBER of SKIN INDENTATIONS: We took into account the number of skin indentations found in 650 patients being treated in our service . The analysis of our data allowed us to classify this condition into 4 degrees of severity with a score from 0 to 3 as follows:

3: more than 10 skin indentations

2: 5 to 9 skin indentations

1: 1 to 4 skin indentations

0: zero skin indentations

PROJECTION: For this criterion we took into account the classification of Wong et al. (1) in which four criteria for the evaluation of the buttocks projection are considered (**Figure 1**).

POSTERIOR VIEW:

1. Waist-Hip Ratio: a/b (Figure 1, above left)

2. Vertical ratio for lateral prominence (Figure 1, above right)

LATERAL VIEW

3. Waist-hip ratio: a/b (Figure 1, below left)

4. Vertical ratio for posterior prominence (Figure 1, below left)

5. VERTICAL PROJECTION (WAIST-TO-HIP RATIO; Figure 1, above left): This criterion examines the waist-to-hip ratio in centimetres in vertical projections. Based on the results of the study, we have standardized 4 categories with an increasing score ranging from 0 to 3 where 0 represents the ideal projection:

3: 0.65 ± 0.15 . very poor projection

2: 0.65 ± 0.10 . poor projection

1: 0.65 ± 0.05 . good projection

0: 0.65 ± 0.025 . very good projection

6. VERTICAL RATIO FOR LATERAL PROMINENCE (Figure 1, above right): This criterion studies at what level the maximum lateral projection of the buttocks is localized:

3: Very poor projection

2: 60:40. Poor projection

1: 70:30. Good projection

0: inferior gluteal convexity. Very good projection

7. HORIZONTAL PROJECTION (WAIST-TO-HIP RATIO; Figure 1, below left): This criterion examines the waist-hip ratio in the horizontal projections:

3: 0.70 ± 0.15 very poor projection

2: 0.70 ± 0.10 poor projection

1: 0.70 ± 0.05 good projection

0: 0.70 ± 0.025 very good projection

8. HORIZONTAL PROJECTION (VERTICAL RATIO FOR POSTERIOR PROMINENCE;

Figure 1, below right): This criterion examines at what level the maximum back projection of the buttocks is localized:

3: very poor projection

2: 30:70. poor projection

1: 40:60. good projection

0: 50:50. very good projection

THE FOUR AREAS OF THE BUTTOCKS: We have divided the buttocks into four areas, which represent the fundamental aesthetic units that are paramount in the aesthetic evaluation of the buttocks (**Figure 2**):

- a. Upper third (over the superior gluteal line)
- b. Medium third
- c. Lower third (around the horizontal gluteal crease)
- d. Lateral gluteal fat deposit (saddlebags)

9. *upper third (over the superior gluteal line)*: it represents the transition line from the back to the buttocks and represents the upper margin of the buttocks. It corresponds to the projection of iliac crests and represents a fundamental area for the aesthetics of the buttocks. Different treatments of cosmetic surgery tend to enhance this specific area.

This area has been assessed as:

3: Absent

2: Poorly represented

1: represented

0: Well Represented

10. *medium third*: it represents the area of maximum projection, it gives the round and harmonious shape to the buttocks and represents a fundamental sector in the aesthetics of the buttocks. This is the area on which cosmetic procedures focus to enhance the overall projection of the buttocks.

This area has been assessed as:

3: Absent

2: Poorly represented

1: represented

0: Well Represented

11. - *lower third (gluteal crease)*: The gluteal crease is a skin fold that defines the buttocks lower area, it does not represent the lower limit of the gluteus maximus muscle which runs obliquely. It is also a very important area for the aesthetics of the buttocks.

This area has been assessed with a score from 3 to 0:

3: Absent

2: Poorly represented

1: represented

0: Well represented

12. *Lateral gluteal fat deposit (saddlebags)*

0: Absent

1: Slightly represented

2: Represented

3: Very well represented

The scores were created in strict accordance with the current guidelines to develop a scientifically reliable and clinically helpful tool (9-13). Using an inductive methodological approach, all scores were combined to obtain the sum of the 12 different cosmetic characteristics to calculate a total buttocks score. This score was used to investigate the scale reliability. The Rasch model was used as

part of the validation process. The inter-rater consistency and the test-retest reliability were also assessed.

The Rasch measurement theory

The Rasch measurement theory was used (RUMM2030 software) to assess the OBAS (14-17). It examines the differences between the observed and the predicted answers to each item to determine the extent to which the data for a set of items matches a mathematical model. When the data matches the Rasch model, the measurement theory (i.e., a score measures a specific construct) is supported by the data. The Rasch measurement theory examines the discrepancies (or the matching) between the observed scores (the raters responses to each item) and the expected values predicted by the Rasch model. These are calculated using a range of statistical tests to assess the scores to each item (16-18). This model allows us to assess the overall score quality. Our results were interpreted as it follows:

Item response category

Each item of the OBAS could belong to four categories (very good, good, poor, very poor), which reflected a progressive continuum for the construct of interest. A threshold is the limit at which the likelihood of responding in adjacent pairs of response options is 50% (16-17). When the categories operate as expected, the thresholds are ordered. “Disordered” thresholds imply that the response categories for that item are not operating as expected. They occur when raters show difficulties to consistently distinguish between the different response options (19). When the response options operate as expected, the score reliability is confirmed (20).

Item matching statistics

The items of a score must match between each other as a set, clinically and statistically. When the items do not match (mismatch), it would be inappropriate to sum the individual item responses to obtain a total score. Matching statistics are usually interpreted in the context of their clinical applications as a set item, but, in general, the residual match should always range between - 2.5 and + 2.5, and chi-square values should not be significant (17).

Item locations

The score items define a progressive continuum, and analysing where the items are located on this continuum shows how well the items map out a construct. Items should be evenly distributed within a reasonable range.

Internal consistency reliability

The internal consistency assesses the extent to which the scale items are consistent to each other and reflect an underlying construct. The internal consistency of the OBAS and its dimensions were estimated using the Cronbach's α coefficient, ranging from 0 (no internal consistency) to 1 (High degree of internal consistency) (Cronbach, 1951). It is considered a measurement of the scale reliability.

Person separation index

These reliability statistics are comparable to the Cronbach's α coefficient and quantify the error associated with subjective measurements in a sample. Higher values show a greater reliability.

Reliability and validity of the OBAS

The inter-rater reliability was analysed to assess the reliability of the aesthetic scales (21).

The scores following a normal distribution obtained by each rater were compared using a paired T test. Reproducibility or test-retest reliability was used to observe if the intra-rater variability could be excluded (22).

All patients were reassessed one month later by the same raters to test the score accuracy and possible changes over time. The total scores obtained one month later following a normal distribution were compared to the initial scores using a paired T test. The same data were analysed using the Pearson test. A value of $p < 0.05$ was considered significant. Continuous variable normal distribution was analysed using the Kolmogorove Smirnov test. All analyses were performed using PRISM, version 5 (Graph Pad, USA). All the authors had full access to the data and took full responsibility for the integrity of the data.

RESULTS

Descriptive statistics

Patient mean age was 37.7 ± 16.1 years (range: 18-53.8). Mean BMI (body mass index) was 24.8 ± 5.1 (range: 19.7 to 29.9). The mean score obtained at the time of the first rating was 18.2 ± 8.3 . At the time of the second rating (one month later), the mean score was 19 ± 2.1 .

Rasch measurement theory

The matching statistics for the Rasch model are summarised in **Table 2** (the observed data matched closely with those expected by the model). The targeting was good and all items in each of the 12 scales had ordered thresholds, which shows that the raters were able to distinguish between the four item options (very good, good, poor, very poor). A non-significant chi-square value confirmed that the 12 scales matched the Rasch model. All the scale items had a residual matching within the recommended range of -2.5 to +2.5. The Person Separation Index values for each scale were greater than or equal to 0.8, indicating a good reliability. These findings supported the reliability and validity of each of the 12 scales for their respective constructs.

Internal consistency reliability: Cronbach's alpha coefficients

All scales exceeded criteria for acceptability, reliability and validity. In particular, Cronbach's alpha coefficients (≥ 0.90) and intraclass correlation coefficients (≥ 0.78) supported scale reliability and validity (**Table 3**). These findings indicated that the items of each scale formed a statistically conformable group, and that these scores were reliable and valid.

Reliability of the OBAS

The Pearson test demonstrated the strong correlation between the scores at first and second evaluation cycle. The second round of assessments confirmed these strong correlations with nearly identical correlation coefficients (with a mean Pearson correlation coefficient value of 0,98).

Inter-rater reliability: No significant difference was observed between the scores obtained by the raters (t test = 1.44; p = 0.15).

Test-retest reliability (intra-rater reliability): All patients were reassessed one month later by the same raters. No intra-rater variability was observed (t test = 1.44; p = 0.16). These analyses results satisfied the necessary conditions for an objective evaluation tool.

Discussion

Sedentary lifestyle, poor nutrition and advanced age inexorably cause significant changes in the body, affecting the beauty, the tone and the harmonious shape of the buttocks. Multiple medical and surgical procedures can improve the shape, the volume and the projection of this area. Several scales for the buttocks have recently been described in literature. Klassen AF et al. (4) developed the BODY-Q assessment scale that examines the whole body, including the buttocks, in patients undergoing post-bariatric surgery. It is a scale that assesses the quality of life and the psychosocial improvement of the patients. This scale is useful but difficult to use and a merely subjective tool. In 2016, Wong et al. carried out a very interesting study trying to make objective assessments on the ideal buttocks, analyzing a large number of subjects, both men and women, between the ages of 18 and 65 and of different ethnicities (1). Like Wong et al., we wanted to assess the posterior projection and lateral projection of the buttocks and insert these criteria in our scale. However their study, as the authors point out, was limited in that more than 90 percent of the respondents live in the United States and by the fact that there were highly disproportionate numbers of Caucasian respondents. Since buttocks aesthetic perception is influenced by a wide range of factors, Heidekrueger et al, illustrated in their study that intercultural and ethnic differences, in addition to the ethnic and geographic background of surgeons and the general public, play major roles in this regard. Particularly in the field of plastic and reconstructive surgery, globalization suggests more and more unified surgical goals, and, with respect to buttock aesthetics, apparently a waist to hip ratio of 0.7 is rated to be attractive by a wide range of people. However, the authors of this study urge all plastic surgeons to take all compounding factors into consideration when defining surgical goals with their patients, which will ultimately aid in achieving optimal aesthetic outcomes, satisfying both surgeon and patient alike (23).

To have a more complete and easy buttocks assessment tool, we inserted in the OBAS four areas, that we treat systematically when we want to achieve a global buttock surgical remodelling (by liposuction and lipofilling and insertion of gluteal prostheses). These areas are represented as: "the four areas of the buttocks". A superior gluteal line, a medium third and well-marked gluteal crease increase the harmony and beauty of the buttocks. However, the excess of fat in the lateral region of the buttocks (saddlebags) represents a defect on which surgeons are often asked to intervene surgically. Skin laxity frequently occurs in areas where a large amount of adipose tissue is covered by a relatively thin layer of skin such as the buttocks, thighs, the region above the knee, and the upper arms. In these areas, the skin is subject to the mechanical action of the weight exerted by adipose tissue and other subcutaneous structures as well as the effects of gravity. The appearance of lax skin on the buttocks can be distressing and is a major cosmetic concern for many people. Treatments to tighten the skin were once restricted to only surgical procedures, but individuals with mild-to-moderate skin laxity are increasingly seeking non-invasive options that have minimal downtime and no scarring (monopolar and bipolar radiofrequency, broadband and laser light sources etc.). This is the reason why we added this criterion in the OBAS. Despite the importance of the previously mentioned tools, a valid and reliable tool to objectively assess the totality of the buttocks has not been described yet in literature. For this reason, our team has developed a tool based on different scales, which appears as a simple, complete method that can be easily used in medical practice (24-27). The only available tool to the surgeon to objectively assess the results of a medical or surgical treatment are pre- and post-operative photos. However, we find it interesting to be able to associate photographs with an objective numerical photograph evaluation tool that can be reproduced and trusted. This is the main reason why we decided to develop the OBAS. This scale can be used not only in a clinical setting to assess the effectiveness of medical or surgical procedures performed on the buttocks, but also with scientific purposes. Since it is based on the statistical analysis, it is an effective, reliable and reproducible tool. The OBAS can be used to give a scientific validity to the clinical results obtained, so that we can give

a more complete view of the outcomes to the readers of our articles. A significant discrepancy between the pre and postoperative score is associated to more effective results of the procedures performed. However, our study has some limitations. First of all, our sample only included Caucasian subjects. Future research could investigate the use of our scales in Black and Asian patients. Secondly, a bias could have been introduced during the patient enrolment process. Further studies are thus needed to confirm our findings and make the OBAS a universally accepted tool for gluteal aesthetic features assessments.

Compliance with ethical standards

All procedures in the study involving human participants have been performed in accordance with the ethical standards of institutional and/or national research committees and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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Table Legends

Table 1: The Objective Buttocks Assessment Scale (OBAS) development.

Table 2. Overall adherence to the Rasch model and Person separation index for each scale

Table 3. Cronbach alpha and intra-class correlation coefficients.

Figures Legends

Figure 1. Evaluation of buttocks projection: Waist-Hip Ratio: a/b (above left); Vertical ratio for lateral prominence (above right); waist-hip ratio: a/b (below left); Vertical ratio for posterior prominence (below right).

Figure 2. Buttocks have been divided into four areas, which represent the fundamental aesthetic units that are paramount in the aesthetic evaluation of the gluteal area: a) upper third (over the superior gluteal line); b) medium third; c) lower third (around the horizontal gluteal crease); d) Lateral gluteal fat deposit (saddlebags)

SDC Legends

Figure, Supplemental Digital Content 1. Representative example of photometrical rating scales for the skin laxity: absence of skin laxity (a); mild skin laxity (b); moderate skin laxity (c); severe skin laxity (d).

TABLE 1: Development of the OBAS

OBAS				
<u>Degree of skin laxity</u>	absence of laxity or relaxation of the skin 0	laxity or mild skin relaxation 1	laxity or moderate skin relaxation 2	laxity or severe skin relaxation 3
<u>Number of stretch marks per buttock</u>	Absence of striae albae 0	<10 striae albae 1	between 10 and 20 striae albae 2	>20 striae albae 3
<u>Cellulite (classification scale by Nürnberger and Müller)</u>	No cellulite 0	1° degree by Nürnberger and Müller 1	2° degree by Nürnberger and Müller 2	3° degree by Nürnberger and Müller 3
<u>Number of skin indentations</u>	Skin indentations 0	1 to 4 skin indentations 1	5 to 9 skin indentations 2	More than 10 skin indentations 3
<u>vertical projection (waist-to-ip ratio)</u>	0.65 +/- 0.025. very good projection 0	0.65 +/- 0.05. good projection 1	0.65 +/- 0.10. poor projection 2	0.65 +/- 0.15. very poor projection 3
<u>vertical ratio for lateral prominence</u>	Inferior gluteal convexity. very good projection 0	70:30. good projection 1	60:40. poor projection 2	Other. very poor projection 3
<u>horizontal projection (waist-to-hip ratio)</u>	0.70 +/- 0.025. very good projection 0	0.70 +/- 0.05. good projection 1	0.70 +/- 0.10. poor projection 2	0.70 +/- 0.15. very poor projection 3
<u>vertical ratio for posterior prominence</u>	50:50. very good projection 0	40:60 good projection 1	30:70 poor projection 2	Other. very poor projection 3
<u>Upper third</u>	Well represented 0	Represented 1	Poorly represented 2	Absent 3
<u>medium third : maximum projection</u>	Well represented 0	Represented 1	Poorly represented 2	Absent 3
<u>lower third (inferior gluteal fold)</u>	Well represented 0	Represented 1	Poorly represented 2	Absent 3
<u>Lateral gluteal fat deposit (saddlebags)</u>	Absent 0	Slightly represented 1	Represented 2	Abundantly represented 3

Table 2. Overall fit to the Rasch model and person separation index for each scale.

SCALE	DEGREES OF FREEDOM	P	X ²	PERSON SEPARATION INDEX
<u>Degree of skin laxity</u>	15	0.16	24.3	0.88
<u>Number of stretch marks per buttock</u>	20	0.56	33.8	0.90
<u>Cellulite (classification scale by Nürnberger and Müller)</u>	20	0.41	15.3	0.89
<u>Number of skin inflections</u>	20	0.15	21.7	0.90
<u>vertical projection (waist-to-hip ratio)</u>	20	0.12	32.4	0.90
<u>vertical ratio for lateral prominence</u>	16	0.74	41.7	0.90
<u>horizontal projection (waist-to-hip ratio)</u>	16	0.23	13.3	0.90
<u>vertical ratio for posterior prominence</u>	20	0.34	34.9	0.90
<u>Upper third</u>	16	0.15	49.5	0.90
<u>Medium third: maximum projection</u>	20	0.25	55.8	0.90
<u>lower third(inferior gluteal fold)</u>	20	0.16	14.8	0.90
<u>Lateral gluteal fat deposit (saddlebags)</u>	20	0.60	33.3	0.90

Table 3. Cronbach's alpha and intra-class correlation coefficients

SCALE	Cronbach's Alpha	Mean Intraclass Correlation Coefficient
<i><u>Degree of skin laxity</u></i>	0.90	0.78
<i><u>Number of stretch marks per buttock</u></i>	0.96	0.78
<i><u>Cellulite (classification scale by Nürnberger and Müller)</u></i>	0.97	0.83
<i><u>Number of skin inflections</u></i>	0.92	0.79
<i><u>vertical projection (waist-to-hip ratio)</u></i>	0.94	0.80
<i><u>vertical ratio for lateral prominence</u></i>	0.98	0.88
<i><u>horizontal projection (waist-to-hip ratio)</u></i>	0.94	0.84
<i><u>vertical ratio for posterior prominence</u></i>	0.95	0.84
<i><u>Upper third</u></i>	0.93	0.78
<i><u>Medium third: maximum projection</u></i>	0.97	0.88
<i><u>lower third (inferior gluteal fold)</u></i>	0.93	0.84
<i><u>Lateral gluteal fat deposit (saddlebags)</u></i>	0.95	0.84

Figure 1

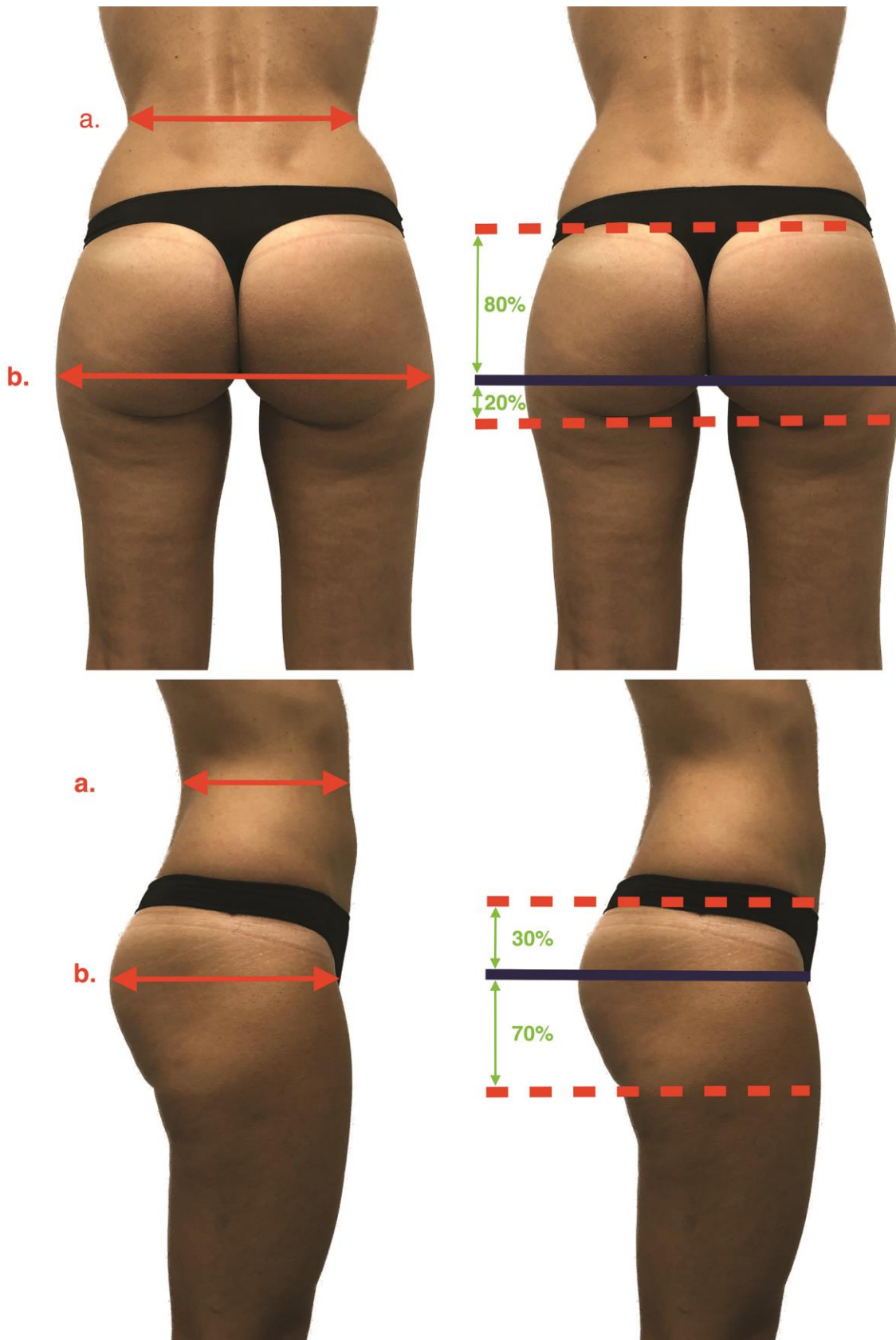
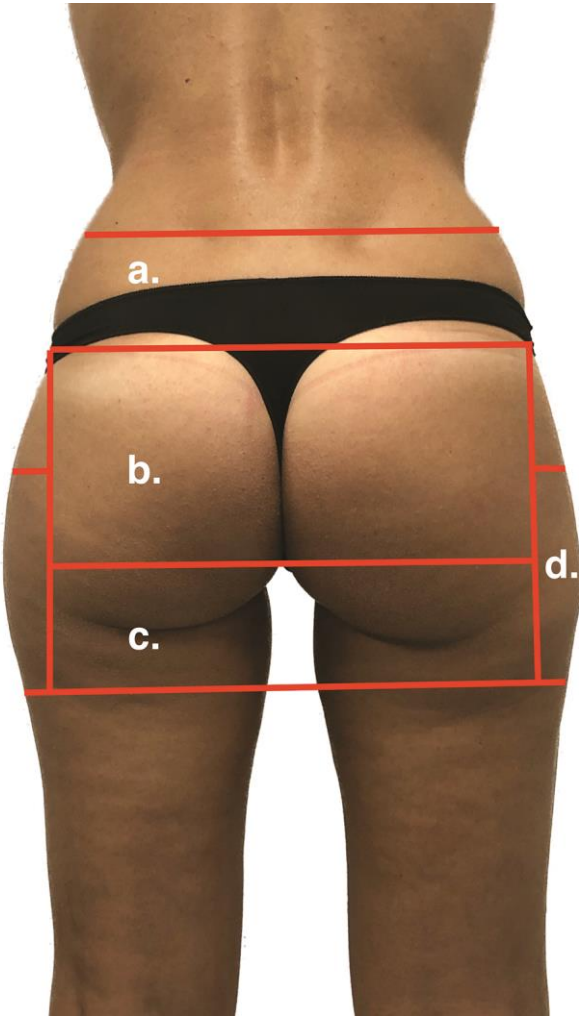


Figure 2



SDC 1

