European Journal of Plastic Surgery (2019) 42:351–358
https://doi.org/10.1007/s00238-018-1486-0

ORIGINAL PAPER

Anatomical position of umbilicus in Latin-American patients

Ricardo Cavalcanti Ribeiro[1,2] · Renato Saltz[1,3,4] · Carlos Ramirez[5] · Luis Fernandez de Cordova[1]

Received: 22 June 2018 / Accepted: 28 November 2018 / Published online: 23 February 2019

Abstract

Background The umbilicus is a natural scar, and the periumbilical area is characterized by a round or ellipsoid shape with a slight depression of 2.5–3.0 cm in diameter. It represents an essential feature in the overall body contour, and consequently exists as one of the most esthetically recognized landmarks on the abdominal wall. The umbilicus lies along the midline at the level of the intervertebral discs between the third and fourth lumbar vertebrae and is considered the only admissible scar on the human body. Given that the umbilicus aids in defining the median abdominal sulcus, it is considered the greatest esthetic component of the abdomen. Thus, the effect of the umbilicus on the esthetic appearance of the abdomen remains key—its position on the abdominal wall and its shape and depth represent important factors influencing conceptions of beauty and psychological well-being.

Methods The aim of this study was to establish a quantitative index by evaluating skeletal landmarks surrounding the anterior wall of abdomen to determine the normal anatomical position of the umbilicus in a sample of Latin-American young women. In this descriptive cross-sectional study, 100 nulliparous Latin-American women, aged 21 to 32 years, were enrolled and examined in the supine position. The mathematical relationship of the umbilicus to various nearby anatomical structures (xiphoid process, pubic symphysis, vulvar commissure, and iliac crests) was determined in order to define its ideal localization.

Results In the majority of patients, we observed a slight lateral deviation of the umbilicus, an average distance measuring 14.55 cm between the xiphoid process and the umbilicus, and an average distance measuring 13.14 cm between the umbilicus and the pubic symphysis, with a ratio of 1.10:1. In patients on whom the umbilicus was located medially, the relationship of the distance between the umbilicus and the anterior superior iliac crest, and the distance between both iliac crests, had a ratio of 0.53:1.

Conclusions Although numerous studies have examined what constitutes the esthetically ideal umbilicus, no publication, up until now, reports mathematical values.

Level of Evidence: Level III, risk / prognostic study.

Keywords Umbilicus · Anthropometry · Abdominoplasty

Introduction

Abdominoplasty is one of the most popular cosmetic surgeries procedures performed in the USA, with 140, 834 procedures in 2017—mostly women (94%), 35–50 years old (53.9%) and 51–64 years old (22.4%) [1]. In Brazil, the patient population receiving abdominoplasty remains demographically similar [1].

The popularity of the abdominoplasty results from the fact that it deals with an area of the body amenable to alteration, but also tolerant to stretching and fat distribution. An abdominoplasty affects nearly the entire appearance of the body and trunk, and has evolved from a procedure consisting of mere amputation of exceeding tissue to that involving whole trunk sculpting.

Furthermore, the abdominoplasty represents a mechanism for the functional and esthetic correction of the abdominal wall when altered by pregnancy, massive weight loss, adipose tissue accumulation, and musculature flaccidity.

✉ Ricardo Cavalcanti Ribeiro
rribeiro@centroin.com.br

[1] Division of Plastic and Reconstructive Surgery, Universidade Federal do Estado do Rio de Janeiro (UNIRIO), Rio de Janeiro, Brazil

[2] Division of Plastic and Reconstructive Surgery of Casa de Portugal Rio de Janeiro, Rio de Janeiro, Brazil

[3] University of Utah, Salt Lake City, UT, USA

[4] Private Clinic Salt Lake City, Salt Lake City, UT, USA

[5] Plastic Surgery Instituto Carlos Chagas, Rio de Janeiro, Brazil

There are different approaches when performing an abdominoplasty. The abdominal dermolipectomy allows the removal of a cutaneous and fat flap from the lower abdomen, with the upper abdominal flap used to cover the entirety of the abdominal wall. The rectus abdominus plication, by contrast, provides approximation of the oblique muscles and waist narrowing. An additional procedure involves fixation of the umbilicus to the rectus aponeurosis and subsequently to the upper abdominal flap.

As previously alluded, the umbilicus exists as the major esthetic landmark in the abdomen since it aids in delineating the median abdominal sulcus. Its absence reveals an unaesthetic abdominal appearance, and an umbilicus with an abnormal shape, or with a different position, can make the central abdomen the focus of unwanted attention.

In addition to the abdominoplasty, the umbilicus is repositioned in a variety of other plastic surgery procedures: mammary reconstruction with transverse rectus abdominus myocutaneous (TRAM) flap and free mammary reconstruction with perforator vessels from the inferior epigastric vessels (DIEP).

The appearance of the umbilicus is influenced by many factors, like abdominal fat thickness, weight gain and loss, pregnancies, hernias, and scars. Studies reveal [2–4] that in young fit women with an appealing abdomen, the umbilicus is small and vertical, while in obese and elderly women, the umbilicus remains transversal and round.

In the literature, the umbilical region is considered to be medial and located in the middle of the linea alba [5, 6] (See the "Discussion" section).

The limits of the umbilicus are as follows: laterally the medial part of the rectus abdominis, and 2 cm cranially and caudally to the umbilical stalk in a horizontal plane. As far as depth, the umbilical region deepens to reach the parietal peritoneum [7].

Chaussier claims that the localization of the umbilicus remains central to the longitudinal axis; however, this is not constant to different people, especially those in different age groups, demonstrating a noticeable degree of variability [8]. In the newborn, for example, the umbilical stalk is infraumbilical. In children 2–3 years old, the umbilicus and the center of the body remain nearly at the same level. As one ages, the umbilicus slowly proceeds to a level above the middle of the body. In 14-year-old children, the infraumbilical segment exceeds the supraumbilical segment by 310 mm according to Dafner (1897), and in 276 mm according to Godin (1903) [9]. In the adult, the predominance of the infraumbilical segment over the supraumbilical segment remains even greater—the umbilicus localizing to a point as high as 20 cm above an imaginary transverse line bisecting the midline of the body [7].

Various studies discuss the anatomic position of the umbilicus [5, 10–14]. According to published literature, the umbilicus does not always lie exactly in the midline in normal individuals, but frequently lies lateral to the midline axis [15]. Surgeons agree that the midpoint between the two iliac crests represents the most appropriate position for the umbilicus [16]. Others suggest that the proper ratio of the distance from the xiphoid process to the umbilicus and the distance from the umbilicus to the pubic symphysis is 1.6:1 [17].

If we consider the ratio from xiphoid process to umbilicus, and umbilicus to pubic symphysis, the xipho-umbilical distance is greater than the umbilical-pubic distance. If we arbitrarily represent the total distance from the xiphoid process to pubic symphysis with the number 100, the distance for the xipho-umbilical line would be 52, and the distance for the umbilical-pubic line would be 48.

When viewed anteriorly in the adult, the umbilicus demonstrates a dome-shaped depression, circumscribed by a cutaneous roll (umbilical roll). In the vertex of this depression, a small irregular elevation separated from the cutaneous roll by a circumferential sulcus (the umbilical sulcus) becomes evident, and upon its vertex lays the umbilical scar.

The umbilical roll is formed by skin and subcutaneous tissue. Exteriorly, it lacks a line of demarcation with respect to the nearby structures. Interiorly, it appears bent and cut so as to appropriately constitute the dome walls. The shape of the umbilical roll remains incredibly variable and changes in accordance with age, sex, and the individual in general. Possible shapes include purely circular, elliptical, semicircular, or comma-shaped (comma-shaped roll). The height of the umbilical roll varies as a result of one's fat content. The umbilical sulcus, by contrast, demonstrates an average circumference of 10 to 15 mm.

As mentioned previously, certain physiological conditions, especially pregnancy, and pathologic states, such as ascites and hernias, modify the normal shape of the umbilicus. During pregnancy, the umbilical depression fades away slowly, and the umbilical ring becomes dilated. After delivery, the ring returns to the former dimensions. Following repeated pregnancies, however, the ring remains dilated, stretched, and loses its prototypical structure. The same is also observed in cases of umbilical hernias.

There are other circumstances, such as umbilical fistulas, where the shape of the umbilicus becomes modified. These fistulas can be of intestinal, vesical, hepatic, or peritoneal origin.

The umbilicus also demonstrates two superficial layers: thin skin and subcutaneous fat tissue. Below the fatty layer of the subcutaneous fat tissue lays the superficial fascia. Within the subcutaneous fat tissue, arterioles, venules, nerve

ramifications, and lymphatic vessels of no major importance can be found.

Beneath the subcutaneous fat tissue, we find the aponeurotic layer (linea alba), formed by the midline fusion of the aponeuroses of the flat abdominal muscles. Seen from the inside, the umbilical ring contains the arcuate fasciculi that forms the Richter sphincter, which tightens and obliterates the umbilical vessels once the umbilical cord is ligated in the newborn. In the retroaponeurotic layers, we find the subperitoneal layer and the peritoneum. In the subperitoneal tissue, we find the umbilical vessels, the urachus (present only in children), and the Richet fascia [7].

The aim of this study was to establish quantitative indices by evaluating skeletal landmarks surrounding the anterior wall of the abdomen to determine the normal anatomical position of the umbilicus in a sample of Latin-American young women.

Objectives

1. Establish anthropometric measurements and localize the umbilical stalk in a sample of young, nulliparous, Latin-American women.
2. Determine the ideal measurements of the umbilicus in the aforementioned sample of women.

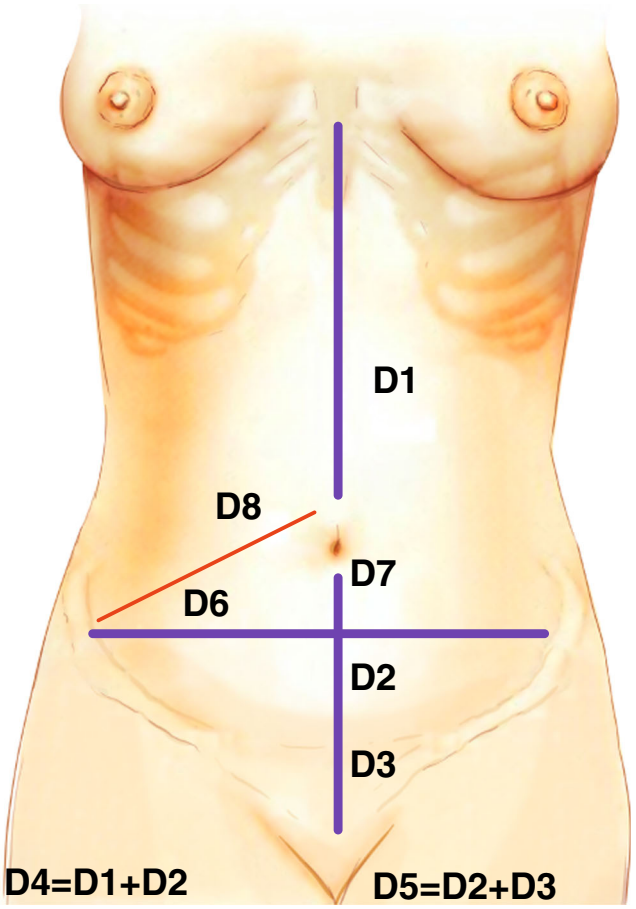

Fig. 1 Points of reference and segments measured in the abdomen

Patients and methods

In this descriptive, cross-sectional study, 100 nulliparous Latin-American women, aged 21 to 32 years, were enrolled and examined in the supine position. The mathematical relationship of the umbilicus to various nearby anatomical structures (xiphoid process, pubic symphysis, vulvar commissure, and iliac crests) was determined in order to define its ideal localization. The study was performed at Santa Casa da Miserocórdia do Rio de Janeiro Hospital, 28th Infirmary, Division of Plastic and Reconstructive Surgery from November 2009 to April 2010. Inclusion criteria were as follows: women between 21 and 32 years of age, nulliparous. Exclusion criteria were as follows: parous women out of the aforementioned age range. All measurements were recorded using the Umbilical Anthropometry Protocol form included below (Fig. 1).

Using a standard 100-cm ruler, the following are distances between the umbilicus and fixed bone structures surrounding the anterior abdominal wall (Figs. 2 and 3)

- D1 (xipho-umbilical): the distance from the superior border of the umbilicus to the xiphoid
- D2 (umbilical-pubic): the distance from the umbilical stalk to the pubic symphysis
- D3 (pubis-vaginal commissure): the distance between the pubic symphysis and the vaginal commissure
- D4 (D1+D2): the addition of these measurements
- D5 (D2+D3): the addition of these measurements
- D6 (between the anterior superior iliac crests): the distance from the left anterior superior iliac crest to the right anterior superior iliac crest
- Point X: point of intersection between D2 and D6
- D7: distance from the umbilicus to point X
- D8: distance between the antero-superior iliac crest and the umbilicus (Fig. 1).

Results

In this study, 100 nulliparous female patients, ranging from 21 to 32 years of age (average age of 26 years old), were

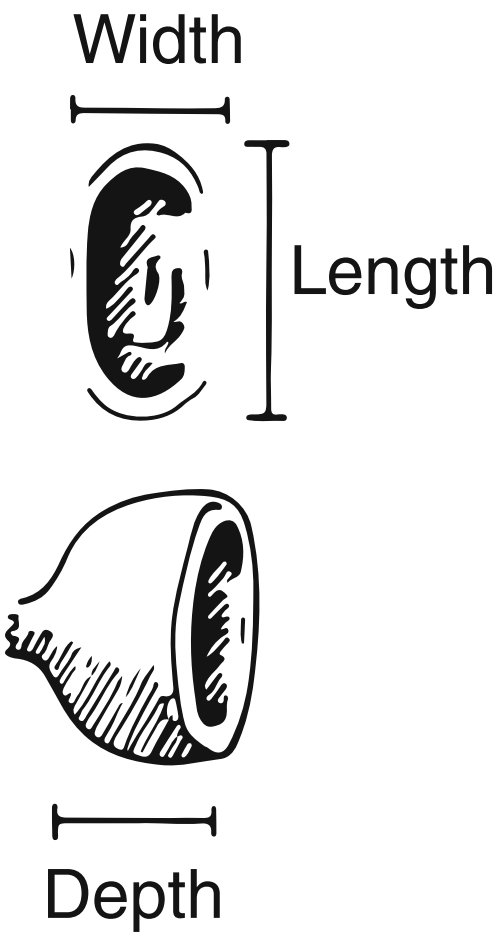

Fig. 2 Umbilicus measurement

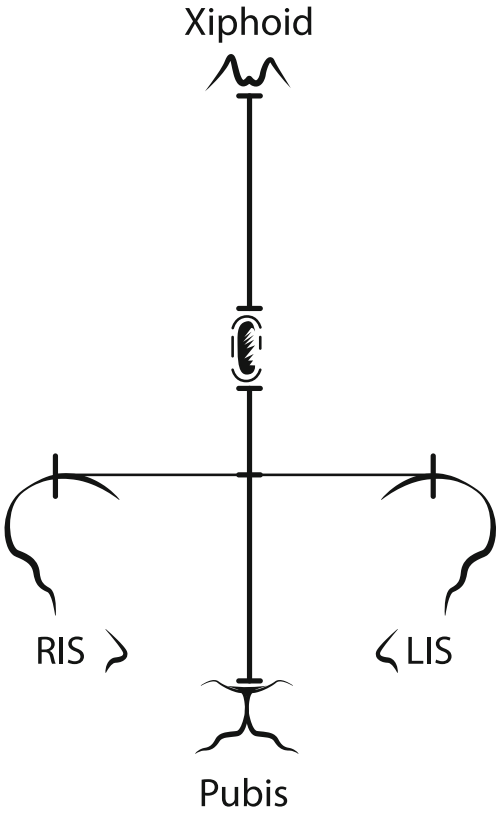

Fig. 3 Measurements between the umbilicus and fixed bone structures

evaluated in the supine position. Sixty-five percent were dark-skinned, 25% were Caucasian, and 10% were of African origin (Fig. 4).

The distance between the xiphoid and the superior border of the umbilicus (D1) was on average 14.55 cm (range of 11 to 18 cm).

The distance between the inferior border of the umbilicus and the pubic symphysis (D2) was on average 13.14 cm (range of 9 to 15 cm).

The distance between the pubic symphysis and the vaginal commissure (D3) was on average 4.59 cm (range of 3 to 6.5 cm).

Thus, according to this data, the distance in the midline of the abdomen from the xiphoid to the pubis (D4) was on average 27.69 cm (range of 20 to 33 cm).

The distance from the umbilicus to the vaginal commissure (the division of the labia majora) (D5) was on average 17.73 cm (range of 15 to 20 cm).

The distance between the antero-superior iliac crests was on average (D6) 36.12 cm (range of 30 to 42 cm).

We observed that most of the patients (80% of cases) demonstrated a slight lateralization of the umbilicus. Viewing the vertical line representing the measurement between the umbilicus and the pubic symphysis (D2), along with the horizontal line representing the distance between the plane of the iliac crests (D6), creates a point of intersection (point X). We subsequently found that the umbilicus was located at a distance (D7) averaging 6.51 cm (range of 5 to 7.5 cm) from this point of intersection superiorly.

Using the Pythagorean theorem ($A^2 + B^2 = C^2$, where C is the hypotenuse of the right triangle), specifically with the measurements representing the distance between the aforementioned point X and the umbilicus (D7), and the midpoint distance between the iliac crests (1/2D6), we can approximate the distance between the umbilicus and the iliac crests (D8) in a patient with the umbilicus localized medially. The exact formula employed was $D8 = \mathrm{sqrt}((1/2D6)^2 + (D7)^2)$. According to this calculation, the average distance between the umbilicus and the iliac crests, in a patient with a medially localized umbilicus, was 19.20 cm.

The width of the umbilicus was 1–2 cm (average of 1.65 cm). The length was 1–2.5 cm (average of 1.38 cm) and the depth was 1–2 cm (average of 1.42 cm) (Fig. 2).

Our study determined that the distance from the xiphoid process to the umbilicus, and from the umbilicus to the pubic symphysis, demonstrates an approximate ratio of 1.10:1.

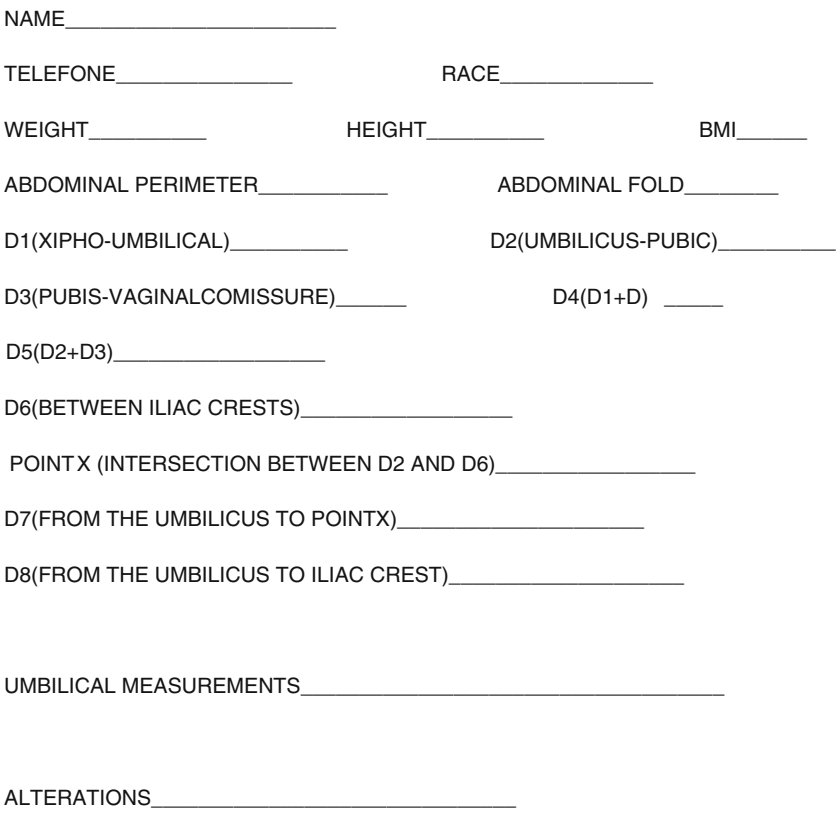

Fig. 4 Umbilical Anthropometry Protocol

Meanwhile, the distance from the umbilicus to the anterior superior iliac crest, and the distance between both iliac crests, has a ratio of 0.53:1 in the cases where the umbilicus is located medially (Charts 1, 2, 3, and 4).

Discussion

Abdominoplasty exists as an esthetic procedure with an elevated index of patient satisfaction due to the extent it can dramatically improve body contouring. The umbilicus is the major esthetic landmark of the abdomen by virtue of the fact that it aids in defining the median abdominal sulcus, and consequently, alterations in its shape or positioning lead to an anesthetic abdominal appearance. Nevertheless, patients readily tolerate the existence of postoperative asymmetries when made aware of these asymmetries preoperatively.

Chart 1 Patient characteristics: arithmetic averages of collected data

Age (year)	Weight (kg)	Height (cm)	BMI	Abdominal fold width (cm)	Abdominal perimeter (cm)
26.15	57.11	159.45	22.46	2.55	73.16

The position of the umbilicus remains variable in obese individuals, particularly depending upon the specific position of the individual (lying down, standing up, etc.). The umbilicus also demonstrates a lower localization in children and the elderly. In fit individuals, the umbilicus is found at the level of the intervertebral disc between L3 and L4, and along the imaginary line connecting the xiphoid process and the pubic symphysis [18].

The anatomical landmarks for localization of the umbilicus localization remain bone-related, and the majority of them exist within the pelvis. This can demonstrate some variability depending on the type of pelvis (gynecoid, android, platypelloid, anthropoid, and asymmetric) present within the individual. Variations in pelvis shape therefore account for some of the difficulty associated with developing accurate measurements of the umbilicus position.

In this study, we observed a localization of the umbilicus 6.51 cm above the horizontal plane joining the anterior superior iliac crests. Dubou e Ousterhout examined 100 individuals selected at random, and described the umbilicus in a higher position than the iliac crest in 96% of individuals, regardless of sex, age, and race [10]. A study conducted by Rohrich et al. measured the

Chart 2 Specific points measured on the anterior abdomen: arithmetic averages of collected data

D1 (cm)	D2 (cm)	D3 (cm)	D4 (cm)	D5 (cm)	D6 (cm)	D7 (cm)	D8 (cm)
14.55	13.14	4.59	27.59	17.73	36.12	6.51	19.20

Chart 3 Arithmetic mean of umbilicus characteristics

Length (cm)	Width (cm)	Depth (cm)
1.65	1.38	1.42

umbilicus position among 136 individuals, in two different trials. In 116 female, randomly selected individuals, photographs were taken and the photos subsequently analyzed. Measurements were conducted at random for 20 of the patients enrolled in the study. The distance between the anterior superior lilac crest and the lateral part of the umbilicus was measured bilaterally as part of these measurements. The results demonstrated that the umbilicus was not in the midline in almost 100% of the individuals, and was more than 2% from the midline in more than 50% of the individuals [12]. Our results were consistent with the Rohrich study in that we observed a slight umbilical deviation from the vertical midline in 80% of the patients.

In 14-year-old children, the infraumbilical segment exceeds the supraumbilical segment by 310 mm according to Dafner (1897), and by 276 mm according to Godin (1903) [9]. In the adult individual, the predominance of the infraumbilical segment over the supraumbilical segment remains even greater—the umbilicus localizing to a point as high as 20 cm above an imaginary transverse line bisecting the midline of the body [7].

If we consider the relationship between xiphoid process to umbilicus to pubic symphysis, the xipho-umbilical distance is greater than the umbilical-pubic distance. If we arbitrarily represent the total distance from xiphoid process to pubic symphysis with the number 100, the distance for the xipho-umbilical line would be 52, and the distance for the umbilical-pubic line would be 48. These proportions remain more obvious in men than women [7].

In Turkey, Onal et al. observed that the normal position of the umbilicus in newborns, in relation to the xiphoid process and the pubis, demonstrated a ratio of 0.61:0.12 [9]. In India, Abhyankar reported a ratio of 1.6:1, for the same structures, in a population of young women [11]. In Brazil, by contrast, we report a proportion of 1.10:1, an average xiphoid-umbilicus distance of 14.55 cm, and an average umbilicus-pubic symphysis distance of 13.14 cm.

We, however, did not observe any significant difference with respect to race. Anthropometry among different races varies, illustrating the necessity of grouping together measurement patterns for each race group or geographic region.

The appearance of the umbilicus depends on many factors, such as abdominal fat thickness, weight changes, pregnancies, hernias, and scars. Studies report that a young and thin women possess an appealing abdomen with a small and vertical umbilicus [2–6]. These findings remain congruent with our observation of an average umbilicus with a width of 1.65 cm, length of 1.38 cm, and depth of 1.42 cm. Perhaps these measurements represent the dimensions indicative of an ideal esthetic umbilicus.

We observed lateral deviation in the majority of cases within this study. The literature describes many surgical procedures intended to reposition the umbilical stalk to the midline—rectus abdominis plication for the vertical and horizontal correction, suturing around the dermis in the periumbilical region, detachment of the umbilical stalk from the rectus aponeuroses, etc.

Since the position of the individual interferes with the correct localization of the umbilicus, all measurements were taken in dorsal decubitus position for this study. In surgery, repositioning is also performed in the dorsal decubitus, and a suggestion by Williams is the use of a suture in the medial abdominal region to mark the vertical line where the umbilical stalk should be localized [19].

Surgically repositioning the umbilicus involves many considerations postoperatively. Simon Chin observed, in 11 pa-

Chart 4 Number of individuals according to umbilical anthropometry

	Length	Length	Length	Width	Width	Width	Width	Depth	Depth	Depth
Measurements (cm)	1	1–1.5	1.5–2	1	1–1.5	1.5–1.9	2–2.5	1	1–1.5	1.5–2
No. of cases	26	37	27	8	52	11	29	9	55	36

Chart 5 Evaluation of 386 patients, divided into 3 groups depending on the type of abdomen

		Umbilicus-pubis distance (cm)	Umbilicus-vaginal commissure distance (cm)
Group 1	Abdomen with a low umbilicus position	12–14	19–20
Group 2	Abdomen with an intermediate umbilicus position	15–16	22–23
Group 3	Abdomen with a high umbilicus position	17 +	24 +

Source: Cormenzana [21]

tients, that following abdominoplasty there is a 2.2-cm reduction of the xiphoid-umbilicus distance after 7 days, and a 2.8-cm reduction after 6 months. Furthermore, there exists a 4.4-cm reduction in the distance between the umbilicus and labia majora after 7 days, and a 5.09-cm reduction after 6 months. The same study also reported that the umbilicus moves in a cephalic direction following abdominoplasty [20].

In Spain, Cormenzana evaluated 386 patients, which he divided into 3 groups depending on the type of abdomen as determined by measuring the distance between the umbilicus and the pubis, as well as the umbilicus and the vaginal commissure. The results were as follows (Chart 5).

Upon comparing the aforementioned, established measurements with our patients, we find that the transfer of these points remains prohibitively difficult. Ultimately, the ratio of these distances (1.10:1 as determined in our study) represents a more easily implementable procedure during abdominoplasty with umbilical repositioning.

Conclusion

Despite of the undeniable importance of the umbilicus, very few studies exist within the literature regarding the umbilicus. In fact, we failed to find any study specifically discussing localization of the umbilicus in Latin America.

After anthropometric measurements, calculations, and ratio analysis, we arrived at the following conclusions:

The distance between the xiphoid and umbilicus, and umbilicus and pubic symphysis, demonstrates an average ratio of 1.10:1.

The distance between the umbilicus and the anterior superior iliac crest, and the distance between both iliac crests, demonstrates a ratio of 0.53:1 in patients where the umbilicus is located medially.

Although the correct anatomical localization of the umbilicus is medial, its symmetry depends on many factors (age, fat distribution, bone characteristics, anterior abdominal wall alterations, etc.), illustrating why we rarely observe this particular anatomical landmark in its ideal position.

Funding None

Compliance with ethical standards

Ethical approval For this kind of study, formal consent from a local ethics committee is not required.

Conflict of interest Ricardo Cavalcanti, Renato Saltz, Carlos Ramirez, and Luis Fernandes declare that they have no conflict of interest. Patient consent patients provided consent before their inclusion in this study.

References

1. ASAPS Tummy Tuck statistics. Source: The American Society for Aesthetic Plastic Surgery accessible at https://surgery.org/sites/default/files/ASAPS-Stats2017.pdf. Acesso em: 12 junho 2018
2. Choudhary S, Taams KO (1998) Umbilicosculpture: a concept revisited. Br J Plast Surg 51:538–541
3. Grant B (1965) Grant's method of anatomy. Williams & Wilkins, Baltimore
4. Baroudi R (1975) Umbilicoplasty. Clin Plast Surg 2:431
5. Craig SB, Faller MS, Puckett CL (2000) In search of the ideal female umbilicus. Plast Reconstr Surg 105:389–392
6. Sinkkonen A (2009) Umbilicus as a fitness signal in humans. FASEB J 23:10–12
7. Moore K. El abdomen. In: Anatomia con orientacion clinica 3. ed. Ed. Panamericana, p 135–151
8. Catteau JF (1876) De l'ombilic et de ses modifications dans les cas de distention de l'abdomen. Méd.–Paris, p 6–28
9. Gal Dini e Lydia Ferreira (2007) Putting the Umbilicus in the Midline. A simple technique to correct umbilicus vertical malposition. Plast Reconstr Surg 119(6):1973–1974
10. Dubou R, Ousterhout D (1978) Placement of the umbilicus in an abdominoplasty. Plast Reconstr Surg 61:291–293
11. Suhas V, Abhyankar MC, Rajguru AG (2006) Anatomical localization of the umbilicus: an Indian study. Plast Reconstr Surg 117:1153
12. Rohrich RJ, Sorokin ES, Brown SA, Diane L (2003) Is the umbilicus truly midline? Clinical and medicolegal implications. Plast Reconstr Surg 112:259–265
13. Dick ET (1970) Umbilicoplasty as a treatment for persistent umbilical infection. Aust N Z J Surg 39:380–383
14. Tanner JM (1981) A History of the study of Human Growth. Cambridge University Press, Cambridge, p 478
15. Ronald Golcman e Benjamin Golcman (2003) Abdominoplastias com cicatrizes reduzidas. In: Melega. Cirurgia plastica fundamentos e arte III (chapter 43). Editora Guanabara Koogan

16. Thorpe SKS, Holder RL, Crompton RH (2007) Origin of human bipedalism as an adaptation for locomotion on flexible branches. Science 316:1328–1331
17. Hodgkinson DJ (1983) Umbilicoplasty: conversion of "outie" to "innie". Aesthet Plast Surg 7:221–222
18. Skandalakis JE et al (2006) Skandalakis' Surgical anatomy. Chapter 4. Abdominal Wall and Hernias. The McGraw-Hill, p 109–208
19. Rosique Marina, et al (2009) Estudo comparativo entre tecnicas de Onfaloplastia. Rev Bras Cir Plast 24(1):47–51
20. Williams AM, Platt AJ (June 2006) Relocating the umbilicus in abdominal surgery. Plast Reconstr Surg 117:2528
21. Cormenzana P (2010) Revision abdominoplasty and proper umbilical positioning. Clin Plast Surg 37:541–546