
CLINICAL SCIENCE

**CORRELATION BETWEEN LUMBAR LORDOSIS
ANGLE AND DEGREE OF GYNOID LIPODYSTROPHY
(CELLULITE) IN ASYMPTOMATIC WOMEN**

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INTRODUCTION: Gynoid lipodystrophy (cellulite) has been cited as a common dermatological alteration. It occurs mainly in adult women and tends to gather around the thighs and buttocks. Its presence and severity have been related to many factors, including biotype, age, sex, circulatory changes, and, as some authors have suggested, mechanical alterations such as lumbar hyperlordosis.

OBJECTIVE: To correlate the degree of cellulite with the angle of lumbar lordosis in asymptomatic women.

METHODS: Fifty volunteers were evaluated by digital photos, palpation, and thermograph. The degree of cellulite was classified on a scale of 1-4. Analyses were performed on the superior, inferior, right and left buttocks (SRB, IRB, SLB, ILB), and the superior right and left thighs (SRT, SLT). The volunteers underwent a lateral-view X-ray, and the angle of lumbar lordosis was measured using Cobb's method (inferior endplate of T12 and the superior endplate of S). The data were statistically analyzed using ANOVA and Spearman's correlation. A significance level of 5% was adopted.

RESULTS: Volunteers had a mean age of 26.1 ± 4.4 years and a mean body mass index of 20.7 ± 1.9 kg/m². There was no significant difference in lumbar lordosis angle between those with cellulite classes 2 and 3 ($p \geq 0.297$). There was also no correlation between lumbar lordosis angle and the degree of cellulite ($p \geq 0.085$ and $r \geq 0.246$).

CONCLUSIONS: The analysis suggests that there is no correlation between the degree of cellulite and the angle of lumbar lordosis as measured using Cobb's method.

KEYWORDS: Cellulitis. Lordosis. Physical therapy. Evaluation. Radiography.

INTRODUCTION

Gynoid lipodystrophy (cellulite) has been cited as a very common dermatological occurrence in post-pubertal women.¹⁻⁴ The skin acquires a padded look or an "orange peel" aspect on the affected areas.¹ Approximately 85% of women in this age group have cellulite,^{1,5} which can be considered a normal aspect in mature women,^{3,5} and not a pathology as it has been called by some authors.³⁻⁶

The term "cellulitis" has been used in the scientific literature in English to identify a spreading gangrenous infection in the subcutaneous cellular tissue;⁷ however, other denominations such as adiposis edematosa,³ lipodystrophy,⁷ edematofibrosclerotic panniculitis⁷ and liposclerosis,⁷ have also been used. These terms differ from each other with respect to pathogenesis and morphology⁷. Rossi and Vergnanini⁸ explained that due to this plurality of names, several authors prefer to use the term cellulite.

Despite the high incidence of cellulite, there is no consensus on the origin and the basic aspects of its histopathological classification.⁷ According to Terranova et al,⁷ there are three main hypotheses concerning the etiopathogenesis of cellulite. According to one theory, cellulite involves an edema in the conjunctive tissue that accumulates a significant amount of water and is caused

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primarily by the accumulation of proteoglycans in the extracellular matrix.^{5,9} These authors suggest that greater tissue hydrophilia leads to a chronic edema that may result in fibrosis.

A second hypothesis attributes cellulite to microcirculatory alterations involving compression of the venous and lymphatic systems.^{1,2,6} According to Terranova et al.,⁷ this circulatory alteration is related to adiposity, since histological examination during the initial stage of cellulite development revealed adipocytes with different forms and sizes associated with edema and dilation of the lymphatic vessels. Rossi and Vergnanini⁸ also reported that blood flow in the cellulite-affected areas was 35% lower than in unaffected areas.

A third hypothesis focuses on the peculiarities of the female subcutaneous tissue.^{2,5,6,10,11} The adipose areolar layer is organized in interlobular septae of conjunctive tissue,^{1,12} which presents perpendicular projections in women and oblique projections in men, a difference that may determine or differentiate the appearance of cellulite in the two genders.^{6,11,12}

Fink et al.¹³ defended yet another hypothesis, which attributes cellulite occurs to herniation of adipose tissue; this herniation is associated with loss of collagen integrity in the affected region.

A detailed clinical assessment^{8,14} and a complete anamnesis including daily habits^{8,14} are required in order to evaluate cellulite and also to establish the presence of factors that can influence cellulite appearance, including the following: hormonal contraceptives,^{5,14} stress,^{5,8} sedentary lifestyle,^{5,8} obesity,^{5,6,14} heredity,^{6,8} age,⁶ sex,^{6,8,15} hormonal dysfunction,^{8,14,15} tabagism,⁸ pregnancy,⁸ excessive intake of coffee and alcohol,^{8,14} inadequate nutrition,^{8,15} circulatory changes^{8,15} and mechanical factors.¹⁴

Sandoval¹⁴ concluded that the following are mechanical factors that can affect cellulite appearance: orthostatic alterations, such as flat-footedness; and lumbar spine alterations, such as hyperlordosis. In addition, Piérard⁵ and Quatresooz¹⁰ reported that in the areas where cellulite was evident, the appearance of the skin changed as a function of the position of the lower limb. Therefore, the authors concluded that body postures tend to compress the adipose tissue in specific areas, thereby enhancing the “skin dimpling” in those areas.

Since cellulite appears mainly in the buttocks and posterior thigh areas,^{3,5,9} changes in the in the curvature of lumbar spine may interfere with the local blood supply, influencing the appearance and degree of cellulite. Therefore, the goals of this study were to compare groups with different degrees of cellulite and different angles of lumbar lordosis, and to assess whether a correlation exists between the lumbar lordosis angle and the degree of cellulite.

MATERIALS AND METHODS

Sample

Fifty female volunteers participated in this prospective study: they were students at a local university and their ages ranged from 20 to 35 years. The women included in this study were asymptomatic, i.e., had no symptoms of neurological, breathing, circulatory or rheumatic diseases. Volunteers filled out an anamnesis and record of daily habits, and the following criteria were used to exclude subjects: sedentary lifestyle;¹⁶ current or previous pregnancy; obesity or body mass index (BMI) greater than or equal to 24.9 kg/m;² previous surgeries related to posture; and lower back pain that has caused some level of incapacity. Subjects received a full explanation regarding the aims of the study and signed a written consent statement previously approved by the Ethical Committee of the University Hospital of University of Sao Paulo.

Physical activity level was assessed using the shorter version of the International Physical Activity Questionnaire in order to classify the subjects into five categories: very active, for those performing vigorous activities ≥ 5 days/week for ≥ 30 minutes per session; active, for those performing vigorous activities ≥ 3 days/week and ≥ 20 minutes per session); irregularly active, for those not meeting the criteria of “active” or “very active”; irregularly active A, for those performing physical activity at a frequency of 5 days/week or a duration of 150 minutes/week; irregularly active B, for those failing to meet any of the criteria for “active” or “irregularly active A”; and sedentary, for those who did not perform any physical activity for at least 10 continuous minutes during the week.¹⁶

Experimental Procedure

For the body evaluation, volunteers were positioned in orthostatism on a wooden base (19 x 37 x 44 cm) and wore bathing suits. The waist-to-hip ratio was calculated using the waist measurement, which was measured at the narrowest point between the ribs and the iliac crest, and the hip measurement, which was characterized at the greatest protrusion of the buttocks. This ratio was also used to determine whether the fat distribution occurred in a central way (android) or in an inferior way (gynoid).¹⁷ Cellulite assessment and photographic registration of the posterior view were performed with and without gluteal muscle contraction.^{8,18} A digital camera (Canon PowerShot A40, 2.0 megapixels) was positioned orthogonally at a distance of 1 m from the wooden base, and the camera lens was positioned based on the height of the sacrum of each volunteer.

The assessed area was delimited using imaginary lines from the posterior superior iliac spine (PSIS) to the inferior gluteus-femoral sulcus, and from the greater trochanter to the inter-gluteus sulcus. A medial line between the PSIS and the gluteus-femoral sulcus was also established, dividing the buttocks area into right superior (RSB) and left superior buttock (LSB), and right (RIB) and left inferior buttock (LIB). In addition to these areas, the third proximal area of the thigh was also included and measured separately as the right superior thigh (RST) and left superior thigh (LST), with right and left defined from the subject's own point of view.

Next, the subjects were positioned in ventral decubitus to perform the palpation of the area under study area to verify the existence and size of the nodules.⁸ After 15 minutes of rest, the delimited areas were subjected to thermograph evaluation using a contact thermography plate with liquid crystals (Cellu-Test®, Milano, Italy). The color of the plate changes according to the skin temperature.⁹ Based on guidelines from the International Products and Service,¹⁹ the outcome image was analyzed by considering the image uniformity, the presence of stains with no definite edges, the presence of clear or black stains, and the homogeneity of the colors.¹⁹ The mean weather temperature registered on the days of data acquisition was $18.7 \pm 3.7^\circ\text{C}$; however, for the coldest days, heaters were used to keep the examination room at a temperature of approximately 20°C .

Considering the data acquired using the techniques previously described (palpation, photography, and thermography), cellulite was classified into one of four levels, according to table 1.^{6,8}

After the cellulite assessment, a standardized X-ray in the lateral view was taken of the lumbar spine including the 12th thoracic vertebra (T12) and the 1st sacral vertebra (S1). The subjects were placed in orthostatic position with their upper

limbs at 90° of flexion. The lumbar angles were measured using Cobb's method, which uses the angle formed between the lines at the level of the superior and inferior endplates of determined vertebrae.²⁰⁻²⁴ Therefore, the angle formed between the lines drawn at the level of the inferior endplate of T12 and the superior endplate of S1 was determined.²⁰⁻²⁶ All the radiological parameters were performed by the same researcher (GBM). The subjects were divided into groups based on lumbar lordosis angle²⁷ measured using Cobb's method (Figure 1).

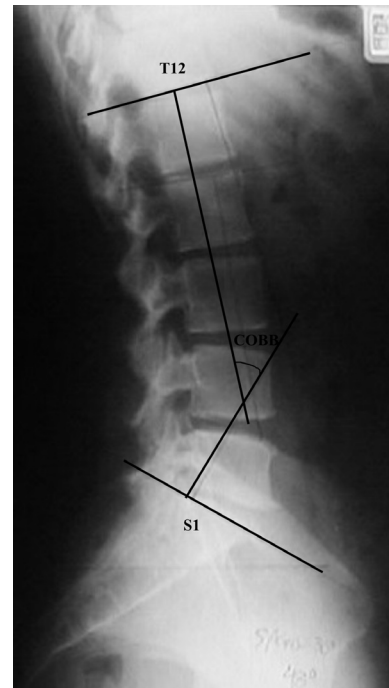


Figure 1 - Total lumbar lordosis angle determined by Cobb's method, using the intersection of lines at the level of the inferior plateau of T12 and the superior plateau of S1

Table 1 - Cellulite classification

Degree 1	Meaning asymptomatic or latent, with no clinical alterations
Degree 2	Alterations were visible only due to palpation or muscle contraction, and they included alterations to the circulatory system, absence of pain, and reduction in skin temperature and elasticity
Degree 3	When an "orange peel" appearance was visible upon simple inspection and alterations were similarly visible even without tissue compression, and the alterations became more apparent under compression, with these changes involving the presence of nodules during palpation and changes in the sensations of pain
Degree 4	Alterations could be observed in any position adopted by the subject, and these were large and painful nodules adhering to the deep tissues. In this last degree, the skin was flaccid and wrinkled, it presented a "nutshell" appearance. Fibrosis was a dominant characteristic, pain sensations were increased, and compromised nervous tissue could be present

Statistical Analysis

Statistical analyses were performed using Bioestat 4.0 software (Brazil). The data were tested for normal distribution using the Anderson-Darling test. The data for the angle of lumbar lordosis were normally distributed; therefore analysis of variance (ANOVA) was performed in order to observe differences among groups. The degree of cellulite was not normally distributed, so the non-parametric Spearman test was performed. The level of significance was set at 5%.

RESULTS

Subjects had a mean age of 26.1 ± 4.4 years and a mean BMI of $20.7 \pm 1.9 \text{ g/m}^2$. The other characteristics considered but not analyzed in the present study are shown in Table 2.

Table 2 - Characterization of the participant cohort

Skin type	
White	35 (70%)
Asian	11 (22%)
Black	4 (8%)
Mean waist-to-hip ratio (cm)	0.73 ± 0.04
Level of physical activity	
Very active	4 (8%)
Active	33 (66%)
Irregularly active A	5 (10%)
Irregularly active B	8 (16%)
Hormonal disturbance	
No	43 (86%)
Contraceptive device	
Pill	23 (46%)
Condom / IUD	7 (14%)
None	20 (20%)
Alcohol intake	
No	28 (56%)
Soft drink intake	
No	13 (26%)
Coffee intake	
No	20 (40%)
Smoking	
No	50 (100%)
Nowadays you spend more time	
Sitting	37 (74%)
Standing	13 (26%)

The mean lumbar lordosis angle was $65.4^\circ \pm 10.9^\circ$, and it ranged from 37° to 89° . The normal lordosis group (n = 33) had a mean angle of $65.4^\circ \pm 10.9^\circ$; the hypolordosis group (n = 10) presented an angle smaller than 54.4° , and the hyperlordosis group (n = 7) presented an angle greater than 76.4° . Among the three groups, there were no differences in the areas under study, degree of cellulite, and lumbar lordosis angle (Table 3).

The correlation data between the degree of cellulite and the angle of lumbar lordosis are presented in Table 4.

For groups having hyperlordosis, normal lordosis, and hypolordosis, Table 5 presents the correlation data between the mode of the degree of cellulite, calculated from the different areas (RSB, LSB, RIB, LIB, RST, LST), and the angle of lumbar lordosis.

DISCUSSION

The purposes of this study were to compare groups with different degrees of cellulite and different angles of lumbar

Table 3 - Mean lumbar lordosis angle. Standard deviation and p values obtained using ANOVA according to the assessed area and the degree of cellulite

Cellulite Area	Degree	Lumbar lordosis angle			Sample Size	p value
		Mean ± standard deviation	Minimum	Maximum		
RSB	2	66.42 ± 11.05	37	89	42	0.414
RSB	3	62.5 ± 9.55	49.5	71.5	6	
RIB	2	64.48 ± 9.66	52.5	89	22	0.423
RIB	3	66.98 ± 11.63	37	87.5	27	
RST	2	63.75 ± 9.39	50	84.5	16	0.345
RST	3	66.88 ± 11.35	37	89	33	
LSB	2	66.61 ± 11.11	37	89	41	0.297
LSB	3	61.93 ± 8.85	49.5	71.5	7	
LIB	2	63.86 ± 10.39	50	89	21	0.264
LIB	3	67.36 ± 10.97	37	87.5	28	
LST	2	63.75 ± 9.39	50	84.5	16	0.345
LST	3	66.88 ± 11.35	37	89	33	

Table 4 - Spearman's correlation (r) and p value for the degree of cellulite and the lumbar lordosis angle

Lumbar lordosis angle	Correlation (r)	p value
Cellulite RSB	0.019	0.894
Cellulite RIB	0.204	0.155
Cellulite RST	0.231	0.106
Cellulite LSB	0.013	0.930
Cellulite LIB	0.246	0.085
Cellulite LST	0.231	0.106

Table 5 - Spearman's correlation (r) and p value for the mode of the degree of cellulite and the lumbar lordosis angle in groups showing hypolordosis, normal lordosis, and hyperlordosis

Groups	Correlation (r)	p value
Hypolordosis	- 0.29	0.415
Normal lordosis	0.03	0.073
Hyperlordosis	- 0.63	0.122

lordosis and to analyze the correlation between degree of cellulite and lumbar lordosis angle measured using Cobb's method.

Though some authors have pointed to hyperlordosis as a factor influencing the appearance of cellulite,¹⁴ the same was not observed in this study, and this discrepancy can be explained due to the different evaluations of posture used by different authors.

The physiotherapeutic postural evaluation was carried out based on the model described by Kendall et al.,²⁸ and this approach takes into account the qualitative and segmental aspects that lead to subjective data. The Kendall model was chosen because it was validated by Penha et al.²⁹ and Griegel-Morris et al.³⁰

During the postural assessment, the outlines of the backs and buttocks were considered instead of the traditional bone landmarks; even so, a greater gluteal prominence could be misleading and cause a false diagnosis of lumbar hyperlordosis.

Mosner et al.³¹ studied the difference between black and white women's lumbar lordosis using X-rays to measure apparent lordosis based on gluteal prominence. They found that the phenotype could interfere with the methods used to evaluate lumbar lordosis. They also concluded that there was no real difference between groups despite the persistent clinical perception of greater lumbar lordosis in black women. Chen²² affirmed that appropriate measurement of lumbar lordosis angle was important for correct clinical decision-making. Consistent with this recommendation, Leroux et al.³² concluded that lordosis quantification has become an important component of patients' evaluation and follow-up. Bernhardt and Bridwell,²⁴ however, said that the angle for normal lumbar lordosis was less defined than the angle for normal thoracic kyphosis. According to Worrill and Peterson³³ the measures for lumbar lordosis have not yet been standardized, and several authors have been using different anatomical landmarks and patient positions during evaluation, making comparisons among different studies difficult.

Jackson and McManus³⁴ attested that an important source of lordosis exists in the L5-S1 region, and that two-thirds of L1-S1 lordosis was distributed below L4. In a study by Polly et al.,²⁶ measuring the interval between T12-S1 showed better intra-observer reproducibility. Thus, in considering total lumbar lordosis, some authors have used the inferior endplate of T12 and the superior endplate of S1 to measure Cobb's angle.^{23,25}

The mean lumbar lordosis angle observed in this study (65.4°) was close to the values observed by other authors^{21,23,25} using different populations. These authors examined individuals of both sexes and of age varying from 10 to 18 years,²³ 20 to 63 years²¹ or above 40.²⁵ Our mean

lumbar lordosis angle was higher than the one reported by Harrison et al.²⁰ (58.6°), who assessed a group of 30 individuals without taking age into consideration.

Correlation between cellulite and lumbar lordosis could be explained by the fact that cellulite is caused not only by the peculiarities of the female subcutaneous tissue,^{2,5,7,10,11} but also by mechanical or orthostatic alterations¹⁴ that in turn could generate circulatory alterations.^{6,7,8,20} However, Querleux et al.¹¹ performed magnetic resonance imaging of the subcutaneous adipose tissue and proton spectroscopy, and found that their results did not support the hypothesis that the water contained in the subcutaneous tissue is the cause of cellulite, as suggested by some authors.^{5,9} This hypothesis may still be valid if the excess water in the patients of the Querleux study was located in the connective septae, since their measurements were limited to the fat lobules and did not differ between women with or without cellulite.

Terranova et al.⁷ emphasized the great plasticity of the adipose tissue, which would not passively suffer the consequences of microcirculatory dysfunctions proposed by the hypothesis that cellulite is caused by subcutaneous water content. The idea that adipose tissue is simply a passive reservoir of energy is no longer valid, since it is now viewed as a complex and active metabolic and endocrine organ.³⁵ Terranova et al.⁷ suggest that the capacities of this tissue recognized nowadays may influence the physiopathology of cellulite, and this influence should be examined.

One limitation of this study is the lack of women with degree 1 and degree 4 cellulite; this presumably reflects the fact that most such woman fall outside the age range of our cohort (18-35 years). Another limitation of this work is that cellulite is a multifactorial condition, which makes it impossible to eliminate intervening variables. Nevertheless, this is the first study to our knowledge that focuses not on the histopathological aspects of cellulite, but on its relationship to postural changes. Thus, the findings described here are relevant to aesthetic physical therapy.

According to Smalls et al.,² cellulite is a complex condition that requires further studies in order to explore additional factors that may influence and modulate the severity of the clinical aspects of cellulite.

CONCLUSION

This study found no correlation between lumbar lordosis angle and degree of cellulite in asymptomatic adult women. However, it is important to consider the method used to perform the postural assessment, so that consistent quantitative data can be obtained that are free from artifacts due to variations in different investigators' postural evaluations. Therefore, further studies with larger

samples and more quantitative data are needed to confirm or refute an association between musculoskeletal alterations and cellulite.

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