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Breast

Newly Identified Gross Human Anatomy: Eight Paired Vestigial Breast Mounds Run along the Embryological Mammary Ridges in Lean Adults

David Teplica, MD, MFA*†‡
Grant Kovich, BS*§
Jamey Srock, BS*
Robert Whitaker, BS*
Eileen Jeffers, BA*
David A. Wagstaff, PhD¶

Background: Although isolated accessory breasts have been reported in many locations on the torso, we noted that lean men presenting for liposuction had mounds of fullness in a curvilinear array (axilla to groin) consistent with the configuration of the embryological mammary ridge. We hypothesized that grid mapping and pinch testing would elucidate the pattern of fullness and its relation to the "milk line."
Methods: Twenty lean participants (10 men, 10 women) each underwent standardized photography and grid mapping of anterior torsos. We then pinch-tested each for subcutaneous fullness in 250 standardized loci. We used plotted pinch values and OLS regression models to determine if focal fullness corresponded to published configurations of the embryologic mammary ridge.
Results: We identified a pattern of paired mounds in all participants running bilaterally in curved linear arrays from axillae to groin in the exact form of milk lines. Regression models applied to the male and female pinch data indicated that focal thickness matched mammary ridge configurations in all subjects ($P = 0.023$ for men, <0.001 for women). Fatty fullness never appeared elsewhere on the anterior torsos.
Conclusions: The linear pattern of paired focal fat mounds present on the anterior torsos is consistent with the paths of embryological mammary ridges, suggesting these focal fat pads are of breast origin. The consistent mounds are distinct from general subcutaneous fullness and therefore represent a new finding of gross human anatomy. We recommend further research to define differential physiology of distinct subpopulations of yellow fat and clinical implications. *(Plast Reconstr Surg Glob Open 2021;9:e3863; doi: 10.1097/GOX.0000000000003863; Published online 14 October 2021.)*

*From *The 803 Foundation, Chicago, Ill.; †Section of Plastic & Reconstructive Surgery, Department of Surgery, The University of Chicago, Chicago, Ill.; ‡The Kinsey Institute, Indiana University, Bloomington, Ind.; §MBA Program, Smeal College of Business, Pennsylvania State University, University Park, Pa.; and ¶Department of Human Development and Family Studies, College of Health and Human Development, Pennsylvania State University, University Park, Pa.*

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INTRODUCTION

If you can measure it, measure it. If you can't measure it, measure it.
—Nobel Laureate Surgeon, Charles B. Huggins, MD[1]

Descriptions of accessory breast tissues appear in historic and current literature. The majority pertains to women, but rare reports describe male findings.[2] Although some publications associate anomalous breast tissues with systemic conditions, the overwhelming majority use a variety of terms to describe benign vestiges of normal breast tissues (eg, ducts, fatty mounds, or accessory nipples).[3,4]

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Data on the incidence of accessory breasts are lacking. However, in a 1907 study, Japanese researchers reported that 5.19% of women and 1.68% of men presented with "polymastia."[5] A 1924 report showed that "polymastia" was a multigenerational phenomenon. In 1939, one author found a 1%–2% prevalence of "supernumerary breasts" among Whites.[6,7] The presence of "ectopic nipples" or "polythelia" has been documented in both genders, and "supernumerary" structures have been reported occurring along the embryological milk line.[8–11] Several well-known anatomic atlases have presented illustrations that visually summarize accessory breasts along curving "milk lines" descending from axillae to proximal thighs bilaterally, including a now-classic diagram by Frank Netter.[12] By contrast, no significant discussion or summation of findings is available for men. Other mammalian species exhibit up to nine pairs of female mammary glands and male counterparts usually develop similar nonlactating structures.[13]

To date, the literature has described human accessory breast tissues as "anomalous" or "pathologic." However, given commonalities with other mammals and informed by clinical findings, we postulated that remnants of breasts in the form of paired adipose mounds along the mammary ridges could represent previously unrecognized normal anatomy in all humans. Unfortunately, we could find no system for measuring relative subcutaneous fullness in a quantifiable, reproducible way to analyze adiposity for the present study. Inspired by Dr. Charles Huggins, we recognized the need to devise a new system of measurement.[1]

Although current culture is obsessed with breasts, no author has presented an overarching, embryologically-based theory to explain the array of anatomic findings present in the general population or changes in breast and body shape that occur over time. Such insights could provide a foundational understanding of basic anatomy, potentially improving clinical analysis and management of a variety of conditions.

While caring for patients with HIV lipodystrophy, the principal author (DT) recognized that focal paired adipose mounds became hypertrophic along the embryonic milk line concurrent with wasting of the surrounding fat. Author DT published an illustration of the mammary ridge concept and postulated that the mounds were embryologically similar, of breast origin, and resistant to HIV-atrophy.[14] Concurrently, HIV-negative men presenting for elective liposuction almost always exhibited paired mounds of adipose in the same locations seen in virus-induced lipohypertrophy. However, unlike in chronic HIV, these mounds were diminutive and grew slowly. In both cases, these paired protuberances occurred at consistent anatomic locations descending from axillae to anteromedial thighs, with the distinct appearance of teats seen in other placental mammals.

We hypothesized that a consistent pattern of small vestigial-breast fat mounds is present in lean healthy individuals and represents previously unrecognized normal human anatomy. To test the premise, we performed a quantitative anatomic analysis using topographic grid mapping, pinch testing of subcutaneous fullness, and standardized photography of the anterior torsos of male and female study participants.

MATERIALS AND METHODS

Study Population

Healthy medical models (10 men, 10 women) ranging in age from 18 to 33 years were recruited from a well-established online modeling website (www.modelmayhem.com) based upon their declared comfort with being photographed nude. The study set was intentionally restricted to young, lean, nulliparous individuals of European extraction, to minimize variation regarding age, BMI, hormonal influence, race, and ethnicity.

This prospective study of human anatomy in non-patient, healthy, paid, medical models meets standards outlined in the World Medical Association's Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Participants. The senior author (DT) is CITI-certified for conducting a biomedical research investigation using human participants and attests to meeting appropriate ethical guidelines. All participants were fully informed of the study design and protocol, gave permission for data analysis and publication of de-identified imagery, and received moderate compensation.

Inclusion and Exclusion Criteria

We measured height, weight, and fat content for each potential participant and excluded individuals if fat content was greater than 14.0% for men or 23.0% for women. Participants were required to be postpubertal and free of known systemic disease, chronic infection, endocrine aberration, or visible skeletal and skin abnormalities. We also eliminated individuals with anterior torso tattoos, piercings, surgical scars, other trauma to the body surface, or steroid exposure. One registered man was replaced as a participant when he revealed receiving anabolic steroids in high school. We recruited women who had never been pregnant beyond 8 weeks from conception.

Anatomic Documentation

To start, we captured a baseline sequence of faceless rotational photographs of the circumferential torso for each participant, using strictly standardized protocols developed by our laboratory and published over the last decade.[15–17]

Anatomic Grid Mapping

The primary author (DT) used Sharpie marking pens, a bubble-level ruler with millimeter increments, and tape measures to ink a grid onto the anterior surface of each participant, anchored by specific anatomic features. To establish the lateral border on each side, we drew a black line from the distal end of the clavicle, wrapping across the insertion of the pectoralis major up and into the apex of the axilla. DT then used single-point perspective to extend the mid-lateral line of the thorax and thigh to the level of the superior border of the patella. To establish vertical sub-divisions, each of the five major horizontal lines was measured from the lateral line to the midline and divided into five equal segments on each side using blue hatch marks. We connected these breakpoints with blue pen to create five vertical columns on each side of the midline.

We labeled columns of cells 0–9, starting at the participant's right acromion, then labeled rows A through Y in cephalocaudal progression. Finally, during isometric contraction of the rectus abdominus, DT outlined the perimeters of each segment in red (if palpable). The resulting anterior grid map contained 250 rectilinear cells (Fig. 1). (**See appendix 1, Supplemental Digital Content 1**, which displays a stepwise checklist of tasks to ensure that each participant was mapped and photographed consistently. **http://links.lww.com/PRSGO/B802**.)

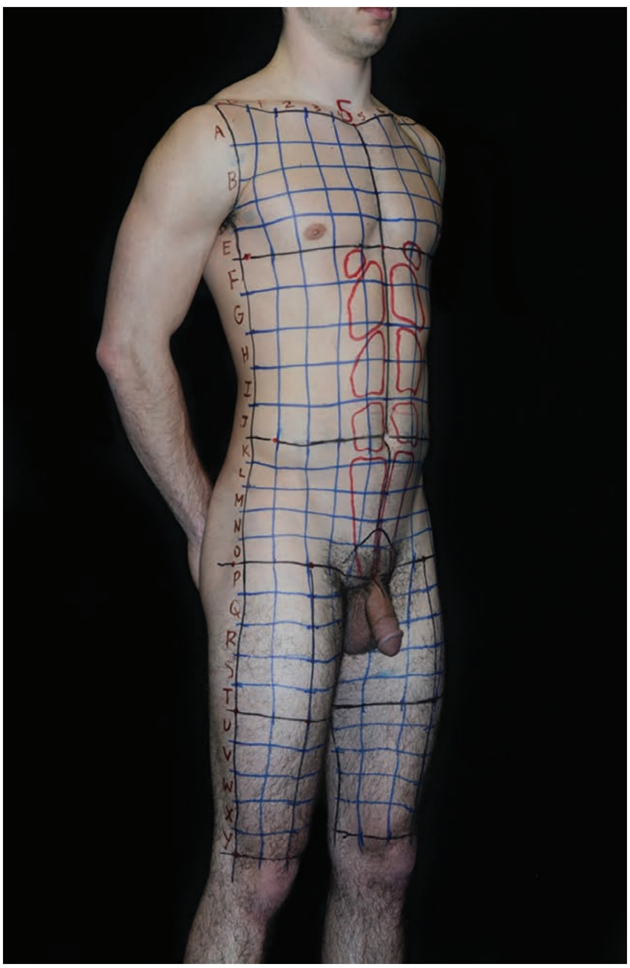

Fig. 1. To standardize creation of the grid for data acquisition, DT placed red dots directly over the following bony landmarks: suprasternal notch, distal-most points of the clavicles, midline xyphisternal junction, bilateral anterior superior iliac spines, midline inferior-most point of the pubic bone, and the midpoints of the superior borders of the patellas. To determine the midpoint of the thigh, we measured the vertical distance between the inferior border of the pubis and the superior border of the mid-patella, divided this by two, and marked a red dot at this distance on the median line of the anterior thigh. DT marked the midline of the body with a near-vertical black line from the suprasternal notch to the inferior border of the pubis. We then used the red dots to divide the torso and lower extremities into five horizontal segments corresponding to chest, upper abdomen, lower abdomen, groin/proximal thigh, and distal thigh using a black pen. Within each segment, we then drew five equal divisions as parallel lines with blue ink to yield 25 rows extending from clavicles to patellae.

Fig. 2. Horizontal pinch testing of subcutaneous fullness using Harpenden Skin Fold Calipers in Grid Cell 4T. Each of 250 cells was tested vertically (longitudinally, as shown above) and horizontally (transversely). The average of these values was used for analysis. Although time-consuming, the process is not painful when performed carefully. This photograph and those in Figure 3 were taken and provided by Joe Ciarrocchi in 2014.

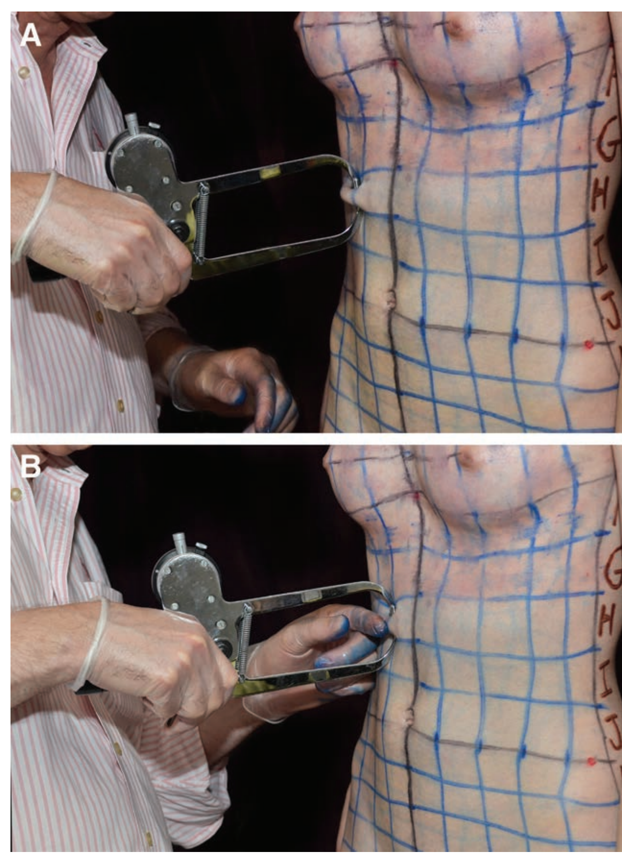

Fig. 3. Shown here are the two methods used to determine volumes in cells where hyperelasticity was present. A, Traditional pinch testing in a region of high skin elasticity yields a value that is artificially low, as stretch of the skin permits extrusion of subcutaneous fullness out of the caliper pincer pads. B, We therefore devised and consistently applied a "containment pinch test" technique where gentle external digital pressure was applied to the skin to keep all tissues within 2 mm of the edge of the pincer pads, more accurately reflecting the actual volume of skin and fat in any given cell. Both the uncontained and contained values were recorded for cells with elasticity, but the contained values were used for statistical analysis.

We captured a set of standardized rotational photographs to document the grid on each participant. Although quadrilateral cells varied widely in their dimensions among participants (resulting from variations in height and bodily proportions), anatomic features appeared in consistent cells on the grid map (eg, male nipples appeared in cells E2 and E7, whereas female nipples were invariably located within 2 cm of the intersection of rows D/E with columns 2/3 and 6/7).

Data Collection from Each Grid Cell

We collected data with participants standing, as this is the gravitational orientation used socially and medically to evaluate and compare body shapes. We employed a standardized data collection sheet and first evaluated each grid cell for the number of pigmented nevi (potential forme fruste accessory nipples), then counted shafts of hair. (**See appendix 2, Supplemental Digital Content 2,** which displays the standardized data collection sheet. **http://links.lww.com/PRSGO/B803**.) We then used anthropometric calipers (Harpenden Skinfold Caliper, John Bull, British Indicators, Ltd., West Sussex, UK) capable of reading to 0.2 mm to pinch-test subcutaneous fullness (Fig. 2).

Some cells exhibited significant skin hyperelasticity, with tissues that protruded significantly beyond the pincer platforms during compression. When this occurred, we recorded two separate pinch-values to better capture relevant data. The first measurement was made with protrusion of tissues. Then, a modified "containment pinch test" was performed by applying just enough pressure to prevent protrusion and keep the full volume of skin and fat between the pincer pads, yielding a higher pinch thickness (Fig. 3). For consistency, DT performed all measurements for the study, with a second member of the team witnessing the caliper values as they were called out to scribes who entered the data into alphanumeric spreadsheets matching the grid maps on participant's bodies. We used four separate spreadsheets to record vertical pinch thickness (from both standard and modified containment techniques), horizontal thickness (both standard and modified values), number of visible hair shafts, and the number and characteristics of any moles. We videotaped each session.

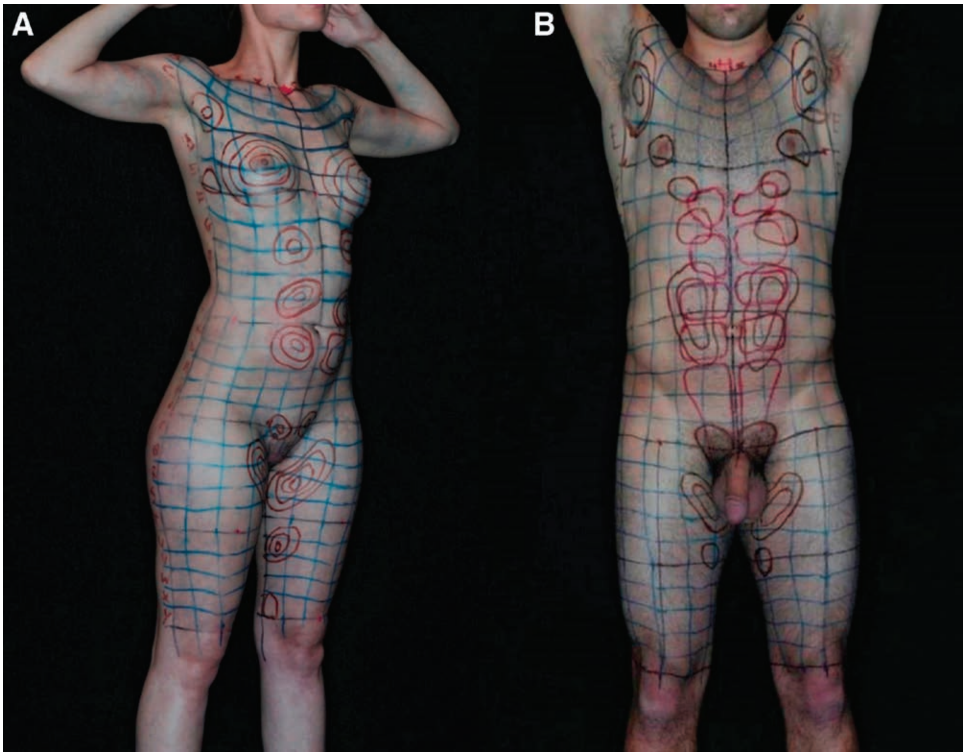

Fig. 4. Representative female and male participants with alphanumeric grid mapping to permit quantification of subcutaneous fullness. A consistent pattern of focal fat pad thicknesses (brown contour rings) ran in linear array from axillae to anteromedial thighs in all subjects, matching the curvilinear lines of the mammary ridges seen in embryos of all placental mammals (as clearly seen in A, above). When palpable, rectus abdominus segments were marked in red for location reference (B). This male subject had 5% body fat content but was unable to achieve abdominal definition with either weight loss or abdominal "crunches." Note that his accessory breast mounds are located between his rectus segments, blocking visualization of abdominal definition. In several participants, additional focal mounds were seen on the medial thigh. However, these were inconsistent and found only in a few participants; so we suspect they are of a different embryologic origin that we have begun investigating.

Topographic Mapping of Focal Fat Mounds and Final Documentation

Once we obtained data for each participant, DT topographically plotted the location and thickness of the focal fat mounds onto the grid-marked skin surface using contour mapping techniques published recently by our group.[18,19] The boundaries and projections of each fat pad were documented on the skin surface in their actual locations using contour rings at 1-cm increments of fullness above baseline (Fig. 4). Finally, we documented the topographic maps with additional sequences of standardized photographs (Fig. 5).

Statistical Methods

Review of existing anatomical and surgical literature, and Google image-searches for "mammary ridge" and "milk line" (performed 12 July 2020) allowed us to map the location of the mammary ridge against the collected data. Using Photoshop, we standardized and summed the 10 highest-ranked, published illustrations to match the proportions of study participants. Figure 6A shows this gridded overlay. Ninety-two of 250 cells had more than 50% of their area filled by the overlay diagram, were plotted in black (Fig. 6B), and identified as the predicted paths for adult mammary ridges. To test our hypothesis that the anterior torso's pinch-tested mounds relate to the embryological mammary ridge, we used linear regression to evaluate the relation between pinch thickness in each cell and the predicted locations.[20–23] (**See appendix 3, Supplemental Digital Content 3,** which displays the statistical methods. **http://links.lww.com/PRSGO/B804**.)

RESULTS

Study Population, Fat Pad Locations, and Subcutaneous Fullness

Age, height, weight, fat content, and BMI were determined and tabulated for both male and female participants. (**See table 1, Supplemental Digital Content 4,** which displays the anthropometric data obtained from the 10 lean male study subjects. **http://links.lww.com/PRSGO/B805**.) (**See table 2, Supplemental Digital Content 5,** which displays the anthropometric data obtained from the 10 lean female study subjects. **http://links.lww.com/PRSGO/B835**.)

Pinch testing revealed paired adipose mounds in the following loci in men: axilla (100%), lateral chest wall tail (20%), sub-areola (100%), anterior-inferior chest wall (100%), upper abdomen (100%), lower abdomen (100%), pubis (100%), and anteromedial thigh (100%). Every woman participating had focal fullness in 100% of these same locations. Importantly, no focal subcutaneous fullness was found anywhere else on the anterior surface of the body in any participant. Therefore, eight specific discreet anatomic loci accounted for 100% of focal adipose

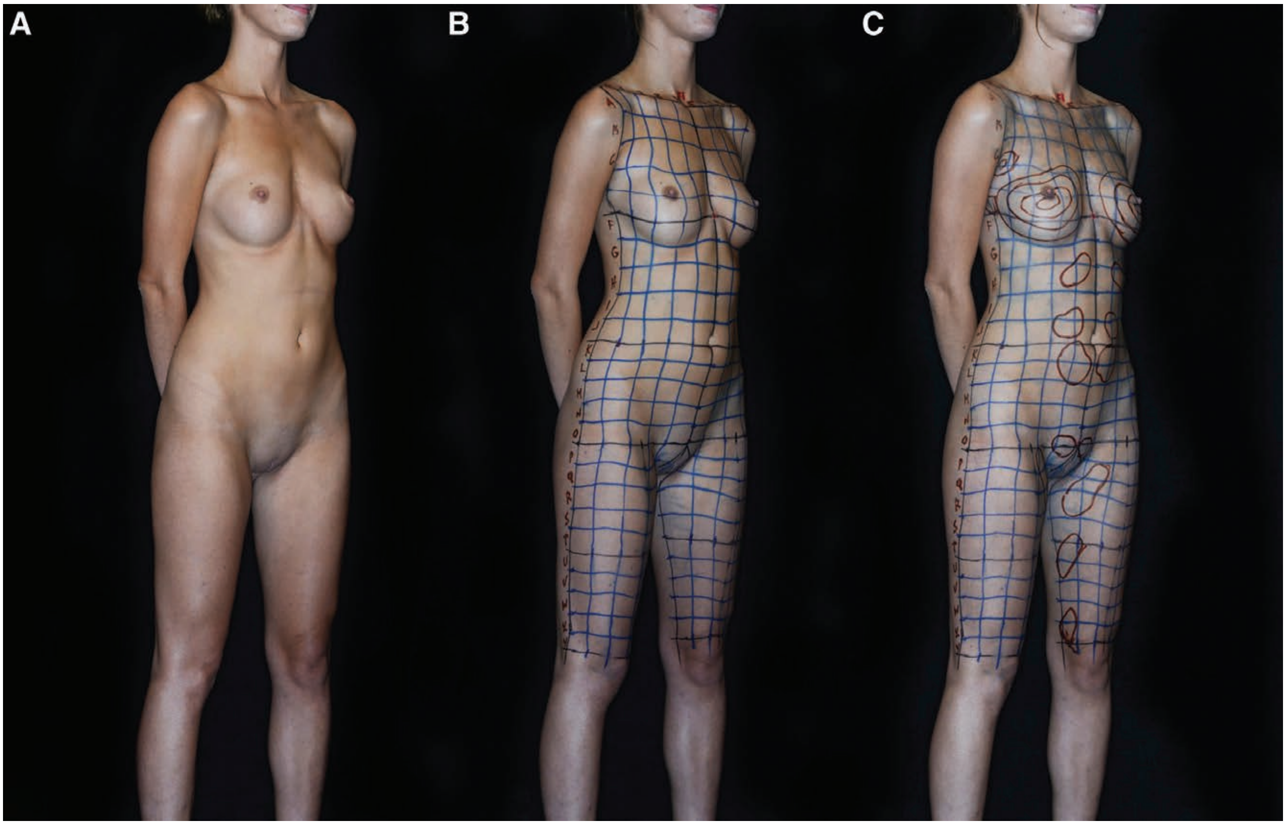

Fig. 5. The stepwise progression of imaging sessions accomplished for each study participant, from unmarked (A), to grid-mapped (B), to pinch-tested and topographically mapped with contour lines defining fullness in each of the identified fatty mounds (C).

among participants. Mounds were always in a curvilinear configuration, extending from axillae to the anteromedial thighs bilaterally (Fig. 7). We saw no relationship between body fat content and the presence, number, or size of the mounds. Tables 1 and 2 display average pinch data from men and women participants, respectively.

Statistical Findings

Table 3 displays the estimates from the separate OLS multiple regression models. In men, the difference between the average pinch measurement for mammary ridge cells and nonridge cells was significant when the covariate identifying the augmented measurements was included (0.027) and when it was not included (0.023). In contrast, among women, the difference between the average pinch measurements for mammary ridge cells and nonridge cells was not significant when the covariate was included in the model (0.115); however, it was significant when the covariate was not included (<0.001). One possible explanation for this may be the greater proportion of female measurements with pinch values of zero, where the skin was directly attached to the underlying fascia, when compared with the male measurements; 52.0% of female horizontal and vertical measurements had pinch values of zero, compared with only 18.7% among men.

Hairs, Moles, and Hyperelasticity

Counts of hairs and moles in cells along the mammary ridge appeared greater than in nonridge cells, but our limited sample size prevents us from drawing distinct

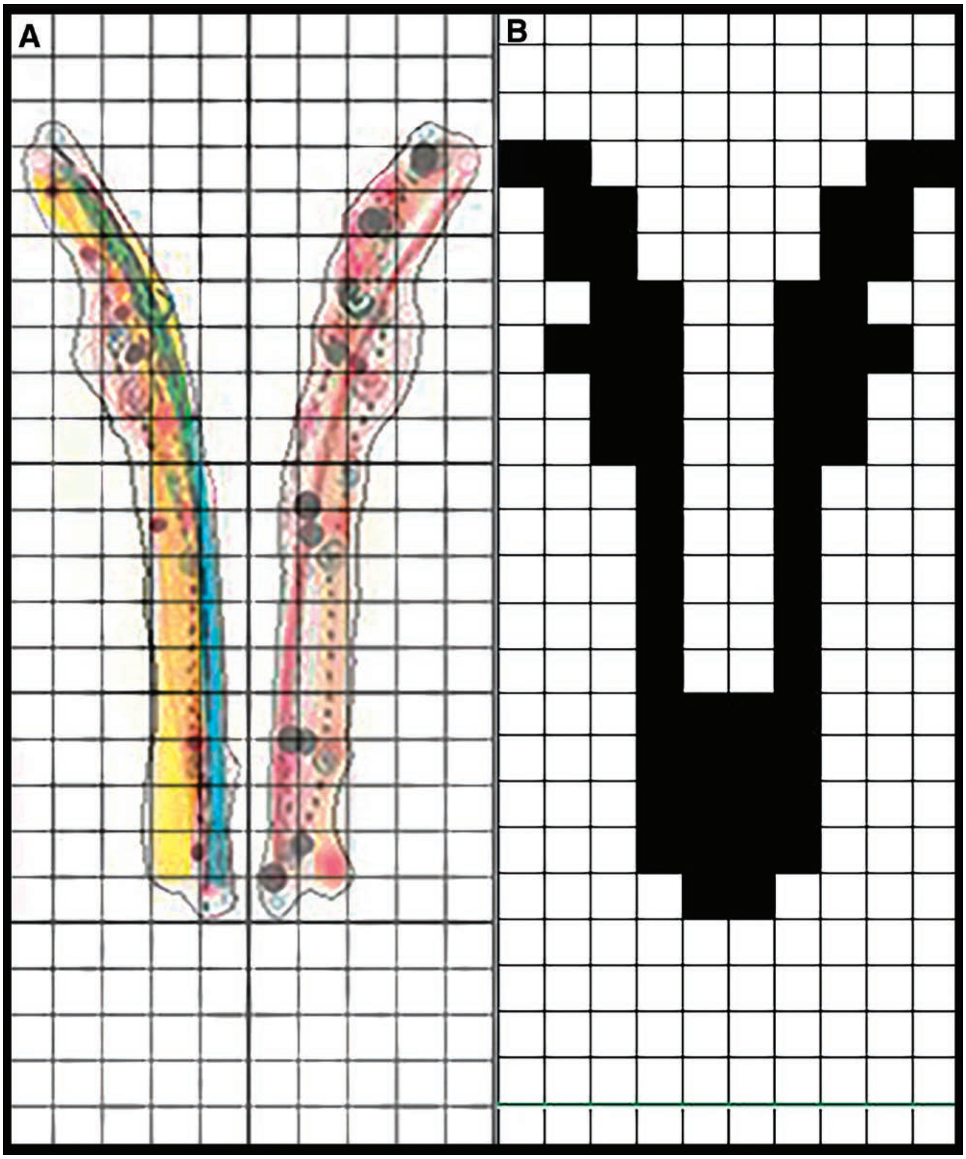

Fig. 6. Shown here is the method used to translate published locations for the mammary ridge to our alphanumeric grid system. A, Summation of 10 published illustrations of the locations of the mammary ridge running down the anterior torso. B, Depiction of grid cells with more than 50% of their areas filled by the overlay diagram on the left. These black cells were identified as the predicted paths for remnants of the embryological mammary ridges in adults.

conclusions. However, those moles present atop focal mounds often had the cobbled appearance of nipples (Fig. 8). We also determined that hyperelastic skin was consistently identified along the mammary ridge (Fig. 9). Supporting our findings, massive weight loss patients can exhibit pendulous focal fullness, laxity, and stretch marks running along the curved mammary ridge lines in the same pattern as our lean participants (Fig. 10).

DISCUSSION

We describe a new method of determining and mapping human subcutaneous pinch thickness by plotting a standardized two-dimensional grid directly onto the entire anterior skin surface of torsos. Pinch testing confirmed that a consistent and previously unrecognized pattern of focal fat mounds is present in our participants, regardless of gender. Paired mounds occurred at regular intervals in predictable locations on the long-known paths of the embryological mammary ridges on the anterior torso bilaterally. This suggests that vestiges of primordial breast fat remain present and anatomically relevant in adults, not having undergone involution during fetal development as previously presumed. Also supporting our findings and hypothesis, review of the English language literature revealed that all reports of accessory breasts on the anterior torso occurred in one of these same eight locations listed and seen in Figure 9. Finally, the concomitant findings of increased hair counts, increased presence of pigmented nevi, and skin hyperelasticity along the same paths provide strong supporting evidence for diminutive functionless breast mounds.

Fig. 7. This composite image of nonparticipant female (A) and male (B) torsos shows the mapped average relative thicknesses for each of the eight mammary ridge mounds by gender. Not visible in this image are the female lateral chest wall tail (average thickness: 2 cm) and the male axillary mound (average thickness: 1 cm). The relative differences in focal fat fullness are likely the primary determinant for how we see gender in the bodies around us each day. Lean men who look masculine typically have little adipose volume in any of the eight mounds. Lean women who look feminine generally have significant fullness (in descending order) in the primary breast mounds, the anteromedial thigh mounds, and the lower abdominal mounds. In the senior author's experience, patients present for elective body contouring procedures when they have either relatively too little or too much adiposity in any given locus, depending upon how they see themselves for gender.

Rather than think of "accessory" breasts as "extras" or "anomalies," we suggest that chains of *vestigial breast mounds* of variable sizes represent previously unrecognized *normal* gross human anatomy. Until now, their consistent presence in healthy adults appears to have gone unnoticed by the scientific community for at least two reasons. The distinction between mounds cannot easily be pinch-identified in any but the leanest individuals. Also, the complex three-dimensional undulating surface of underlying bones and muscles makes it difficult to see the pattern of these small protrusions running linearly down the torso.

Our observations align with previous publications regarding the embryonic mammary ridge, including a developmental anatomy textbook from 1948, the fourth edition of *Principles of Surgery* from 1984, and a more recent report of an ectopic breast from 2012.[23–25] However, these only invoke descriptions of the mammary ridge to explain abnormalities, not as rationale for normal fat pad anatomy. Importantly, we agree with at least one other author that focal accessory breast mounds should not be considered pathologic and that these mounds do not warrant "medically necessary" removal, except in rare cases when diagnostic tests suggest otherwise. Unlike primary breasts, mammary ridge mounds do not normally include ductal elements and have a negligible risk of malignant transformation.[26]

We also suggest that vestigial mounds along the milk line, regardless of gender, should be less responsive to weight loss because we found fat mounds in our leanest participants, agreeing with a study published in 1980, which showed little association between body fat content and breast size.[27] Also, in HIV lipodystrophy, body-wide subcutaneous fat can be lost entirely, while focal mounds along the mammary ridge continue to enlarge in an aberrant breast-like fashion, unhampered by disease progression.[14] Clearly, vulnerabilities of these two subpopulations are vastly different. Previously published work, our pinch data, and clinical observations all support the concept that there are likely two major subpopulations of subcutaneous yellow fat: diffuse, body-wide subsurface adipose and paired focal mounds of primordial breast

Table 1. Plot of Average Pinch Thicknesses for Each Grid Cell among the 10 Male Participants (Averages of Horizontal and Vertical "Contained" Pinch Values)

	0	1	2	3	4	5	6	7	8	9
A	5.21	5.00	4.39	4.49	4.54	4.42	4.40	4.24	4.81	5.13
B	4.95	5.21	5.56	5.32	5.01	5.33	5.69	6.27	5.42	5.02
C	4.00	6.53	7.41	7.10	5.17	5.32	7.17	8.12	7.57	3.83
D	11.23	7.34	8.54	8.98	4.82	5.07	9.85	10.06	8.62	11.29
E	8.18	9.42	12.46	10.42	5.73	5.86	10.55	12.67	10.33	8.09
F	7.03	7.47	9.05	9.56	6.43	6.80	10.06	9.08	7.74	6.98
G	6.78	6.65	8.61	10.21	7.67	7.59	10.12	8.29	6.64	6.75
H	7.65	6.90	7.82	11.19	10.76	9.91	11.80	7.74	6.69	7.25
I	8.94	7.78	8.55	12.53	11.77	11.61	12.84	8.15	7.55	8.72
J	10.42	8.23	8.94	13.33	11.37	10.99	13.68	8.80	8.69	10.68
K	8.99	7.48	8.41	14.58	13.98	13.55	12.64	8.68	7.99	9.18
L	6.82	5.97	6.19	10.38	10.39	10.86	9.42	6.33	5.94	6.98
M	6.36	5.36	4.74	5.33	6.33	6.49	5.81	4.57	4.84	6.31
N	6.96	4.48	4.39	5.08	5.98	5.61	5.09	4.02	4.72	6.67
O	6.56	5.78	4.27	6.42	13.29	12.97	4.88	3.98	6.12	7.69
P	4.63	5.02	5.54	5.07	8.59	9.36	4.73	5.54	6.13	5.32
Q	3.66	4.53	4.71	10.82	3.75	4.38	10.50	5.87	4.19	4.41
R	1.49	4.02	5.86	13.23	7.95	6.37	11.77	6.85	5.39	1.66
S	2.16	2.88	6.60	12.48	10.03	8.79	12.59	6.87	5.71	2.26
T	1.83	3.94	5.81	9.58	8.73	8.65	8.18	6.78	5.51	2.08
U	2.48	3.10	4.10	4.99	5.58	5.81	3.80	5.31	4.42	2.33
V	2.53	3.92	4.52	3.77	2.46	2.43	3.72	4.37	4.84	2.75
W	3.49	4.52	5.36	3.87	3.32	2.73	2.77	6.13	6.21	3.74
X	5.10	7.32	7.99	6.84	5.06	4.66	4.95	7.98	8.53	5.54
Y	5.38	8.27	7.97	7.32	8.08	6.96	7.81	8.59	8.93	6.44

We substituted a value of 0.1 mm for zero in any cell when the caliper could not detect a value for pinch thickness. Note that three data cells on both the left (M0, N0, and O0) and the right (M9, N9, and O9) show unrelated fullness from the anterior-most portion of flank fat wrapping anteriorly from focal fat mounds on the back. In any row, the two thickest cells on each side of the body are shaded gray to help visualize the curvilinear pattern of fullness.

fat. Perhaps adipose should now be classified into four major subtypes: brown fat of newborns, internal visceral fat, focal yellow embryonic breast fat, and diffuse yellow subcutaneous fat.

Our observations also have implications for donor site selection for harvesting fat grafts. Mammary ridge fat and visceral fat appear to survive both disease and autologous transfer procedures better than general subcutaneous fat,[14,28] with the exception that in our experience, fat harvested from the lower abdominal mounds survives lesswell for unknown reasons.

Finally, we propose that variability in relative size of mammary ridge mounds accounts for the wide variety of body shapes seen throughout society. Factors like

Table 2. Plot of Average Pinch Thicknesses for Each Grid Cell among the 10 Female Participants (Averages of Horizontal and Vertical "Contained" Pinch Values)

	0	1	2	3	4	5	6	7	8	9
A	2.70	2.75	2.00	1.88	0.67	0.47	1.74	2.24	2.71	3.04
B	3.93	4.31	2.37	1.83	0.88	0.94	2.76	3.54	4.79	4.68
C	9.21	5.88	3.53	3.64	0.91	0.89	3.38	4.90	8.76	8.33
D	9.70	8.69	7.29	14.25	3.61	3.12	13.29	13.69	14.14	11.65
E	9.17	14.78	17.04	16.61	4.10	3.96	14.00	17.95	11.64	8.42
F	4.96	5.49	5.99	6.12	4.77	4.89	6.83	5.57	5.74	5.92
G	5.78	5.69	7.06	8.07	6.52	6.62	8.87	5.54	6.09	6.35
H	7.51	7.77	9.12	7.87	7.84	8.32	10.42	7.53	6.96	7.54
I	7.84	8.60	6.87	10.84	17.36	9.71	9.97	7.96	7.62	6.85
J	6.22	6.40	6.99	13.30	11.70	11.85	14.04	7.26	6.10	7.25
K	2.09	1.98	3.97	12.33	11.75	11.54	9.16	4.63	2.53	1.86
L	0.99	0.98	1.10	6.93	9.54	9.95	6.83	1.08	1.03	1.19
M	0.71	0.49	0.98	1.23	2.23	1.94	2.12	1.00	0.85	0.68
N	0.54	0.44	0.50	2.04	4.35	4.51	1.38	0.85	1.24	0.90
O	0.10	0.10	0.41	3.92	10.93	10.38	1.95	0.60	0.57	0.64
P	0.10	0.61	1.06	1.83	11.70	10.78	1.56	1.38	0.96	0.10
Q	0.10	0.10	1.05	10.56	2.84	2.91	9.19	1.79	0.10	0.10
R	0.10	0.10	1.97	11.69	12.54	13.16	11.26	1.58	0.98	0.10
S	0.10	0.10	1.96	8.91	15.72	15.85	8.19	1.73	0.90	0.10
T	0.10	0.10	1.91	6.90	13.66	12.85	5.93	2.34	2.19	0.10
U	1.35	1.03	1.10	2.72	6.66	7.39	5.90	2.01	2.05	0.10
V	0.91	0.92	1.04	2.61	2.45	3.39	2.17	1.60	1.83	1.61
W	1.20	1.50	2.79	2.21	4.36	6.07	2.17	2.22	1.65	1.43
X	0.73	0.65	0.90	2.03	3.82	2.93	2.23	3.11	2.73	1.69
Y	0.69	0.60	2.47	5.41	3.92	5.29	4.16	2.48	2.55	0.95

We substituted a value of 0.1 mm for zero in any cell when the caliper could not detect a value for pinch thickness. In any row, the two thickest cells on each side of the midline are shaded gray. Note that women did not show the same fullness laterally from posterior flank fat seen in men in Table 1. This gendered difference is consistent with the anatomy of flank fat we published recently.[18]

Table 3. Estimates from the Separate Ordinary Least Squares Multiple Regression Models Applied to the Male and Female Data

Estimates Based on Male Regression Model							
						95% Confidence Interval	
Covariate Included	Cell Type	Margin	Std. Error	t-Statistic	*P*	Lower Limit	Upper Limit
	N	6.68	0.60	11.08	0.000	5.32	8.05
Yes	R	7.71	0.93	8.31	0.000	5.61	9.81
	Difference	1.03	0.39	2.65	0.027	0.15	1.91
	N	6.60	0.60	10.92	0.000	5.23	7.96
No	R	7.99	0.97	8.23	0.000	5.79	10.19
	Difference	1.39	0.51	2.74	0.023	0.24	2.54
Estimates Based on Female Regression Model							
						95% Confidence Interval	
Covariate Included	Cell Type	Margin	Std. Error	t-Statistic	*P*	Lower Limit	Upper Limit
	N	4.92	0.17	28.28	0.000	4.53	5.32
Yes	R	5.65	0.35	16.15	0.000	4.86	6.44
	Difference	0.72	0.41	1.74	0.115	−0.21	1.66
	N	4.28	0.70	6.16	0.000	2.71	5.86
No	R	7.77	0.65	11.87	0.000	6.29	9.25
	Difference	3.49	0.48	7.28	0.000	2.40	4.57

Inclusion of a covariate when the calipers could not detect any pinch value ensured that each subject had the same number of horizontal and vertical measurements and allowed us to address bias by using 0.1 mm for each subject's nondetects, no matter where they occurred.

familial patterns of focal fat fullness, hormonal shifts like pregnancy, andropause, and menopause, some disease processes like diabetes and Cushing's disease, and several pharmaceutical exposures can all lead to body shape dissatisfaction and become chief complaints for those seeking surgery. We also have a strong suspicion that perception of sexuality ("gaydar") may be primarily determined by subconscious recognition of patterns of relative fullness (or lack of fullness) of specific focal mounds, though further work is needed to draw conclusions. Based upon these preliminary observations, we postulate that embryonic fat pad differentiation may be temporally related to differentiation of the hypothalamus and suggest this link be investigated.

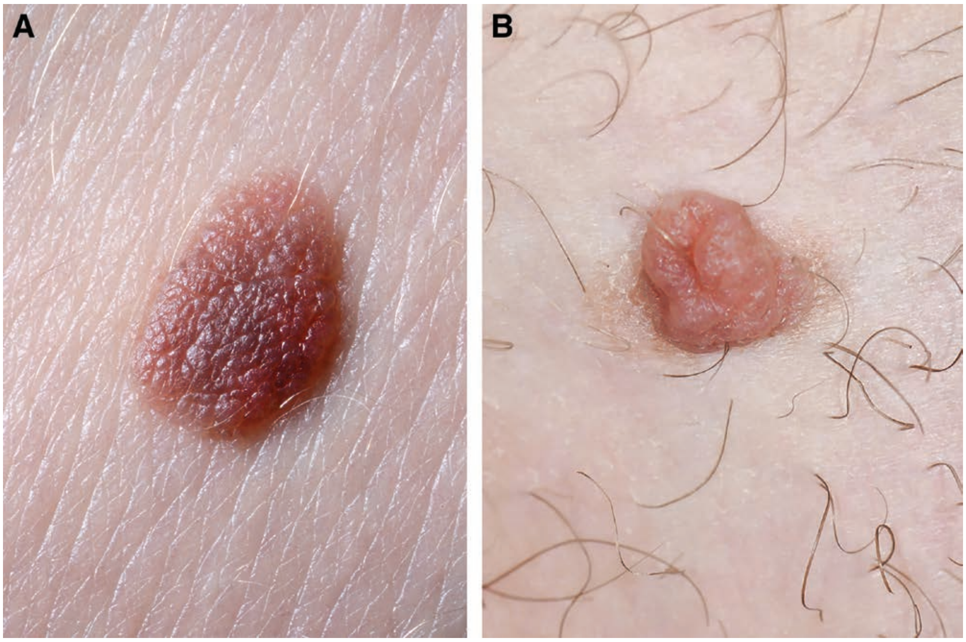

Fig. 8. Commonly seen "nevi" atop focal fat pads located along the path of the embryological mammary ridge, including upper abdominal mound (A) and pubic mound (B). These benign skin findings likely represent forme fruste nipples, often surrounded by rings of flat, pigmented, and less-cobbled skin, which may represent vestigial areolae (B). With or without the presence of pigmented skin structures, clusters of hairs are often seen over fat pads along the mammary ridge in higher numbers and of different character (thicker, darker, or more curled) than in the skin of the surrounding region.

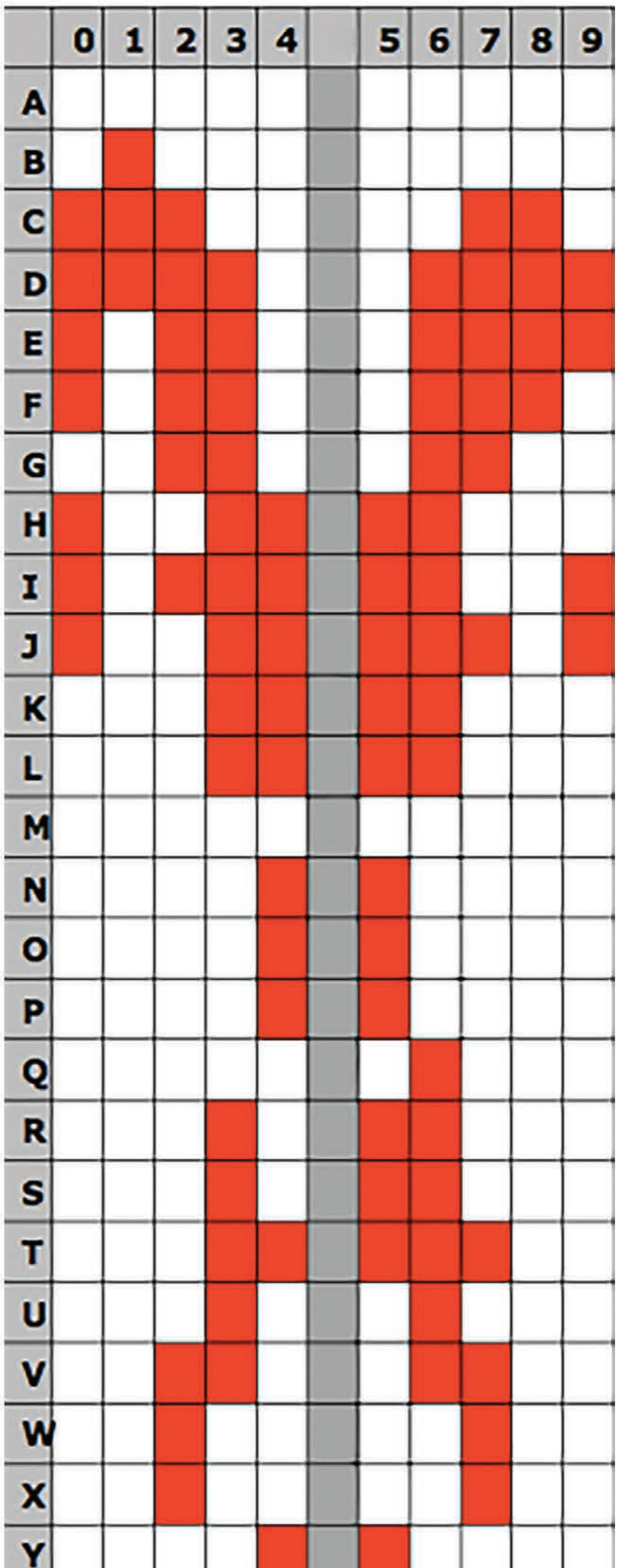

Fig. 9. Grid cells that exhibited hyperelasticity in more than 50% of male participants were colored red. Note that the pattern of elastic skin matches the curved linear configurations of the mammary ridges running from the axilla to superomedial thigh on each side. Female participants showed the same pattern for hyperelasticity.

Fig. 10. Image of a patient following massive weight loss, from the front while bending forward 45 degrees, with penis tucked back. Note the mirrored ridges with focal pendulous skin and residual excess fat in curvilinear arrangements running from axillae to the anteromedial thighs. Eight focal mounds are in the same locations identified in our lean study participants: (1) axillary breast, (2) lateral chest wall tail, (3) primary breast, (4) anterior inferior chest wall mound, (5) upper abdominal mound, (6) lower abdominal mound, (7) pubic mound, and (8) anteromedial thigh mound. Note that most stretch marks run along the crest of each ridge.

Limitations of the Study and Future Investigation

The current study is limited in several ways. Our sample size is relatively small, but among our 20 qualifying subjects, we gathered more than 20,000 unique data values for analysis, and the consistent pattern of focal adiposity shows great statistical significance. Participants were not selected at random by an individual blind to the purpose of the study; however, after meeting the stringent inclusion/exclusion criteria, were enrolled sequentially as they responded to our recruitment postings, without any additional selection from our team.

Although it may be perceived that having a single investigator performing all measurements could induce bias, we anticipated this concern and had every pinch measurement witnessed by another member of the team. We also video documented every skin evaluation made and each pinch-test performed, so that values from every cell can be validated.

The focus on participants of ethnic European extraction restricts our ability to extrapolate findings to other populations. However, the senior author has noted that findings among the diverse patients in his surgical practice consistently match this study's findings.

We conducted pinch testing only on the anterior surface of the body for the present study, but clinical experience (especially with patients having HIV lipodystrophy) reveals similar paired adipose mounds on the posterior body surface. Our group has therefore begun to define fat pad anatomy for the remainder of the torso and all four limbs.

CONCLUSIONS

Grid mapping and pinch testing show that healthy lean adults consistently exhibit eight pairs of vestigial breast mounds along the previously described embryological milk line. These focal areas are associated with increased overlying hair counts and the presence of moles that may represent forme fruste areolas or nipples. Also, skin along the milk line is hyperelastic, perhaps providing less of an impediment to volumetric expansion of breasts during puberty and pregnancy. Variable fullness of these paired mounds likely accounts for the full spectrum of human body shapes, including anatomic differences that allow us to perceive genders, states of health or disease, relative ages, and the sexualities (in our strong, albeit preliminary observations) of those around us. We believe that our findings provide a framework to better understand adipose anatomy and physiology within a newly envisioned embryological context that honors all previously published observations we have found.

With the recent burst of interest in liposuction and autologous fat transfer, these anatomic findings provide insights to improve surgical planning and three-dimensional outcomes. Finally, whether for reconstructive or aesthetic needs, selection of fat grafts from donor sites with specific adipose physiologies should enhance graft stability and long-term results.

David Teplica, MD, MFA
803 W Hutchinson St
Chicago, IL 60613
E-mail: doctor@davidteplica.com

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REFERENCES

1. Huggins C. Personal communication with Teplica D. Ben May Laboratory, Department of Surgery. Chicago, IL: The University of Chicago; 1988.
2. Boivin S, Segard M, Delaporte E, et al. [Complete supernumerary breast on the thigh in a male patient]. *Ann Dermatol Venereol.* 2001;128:144–146.
3. Corsi F, Sartani A, Rizzi A, et al. Primary carcinoma of ectopic breast tissue. *Clin Breast Cancer.* 2008;8:189–191.
4. Meggyessy V, Méhes K. Association of supernumerary nipples with renal anomalies. *J Pediatr.* 1987;111:412–413.
5. Iwai T. A statistical study on the polymastia of the Japanese. *Lancet.* 1907;2:753–759.
6. de Cholnoky T. Supernumerary breast. *Arch Surg.* 1939;39: 926–941.
7. Klinkerfuss G. Four generations of polymastia. *JAMA.* 1924;82:1247–1248.
8. Shinn L, Woodward C, Boddu S, et al. Nipple adenoma arising in a supernumerary mammary gland: A case report. *Tumori.* 2011;97:812–814.
9. Kazakov DV, Kacerovska D, Michal M. Lactation adenoma in a supernumerary nipple. *J Cutan Pathol.* 2011;38:532–533.
10. Page RN, Dittrich L, King R, et al. Syringomatous adenoma of the nipple occurring within a supernumerary breast: A case report. *J Cutan Pathol.* 2009;36:1206–1209.
11. Mak CT, Veras E, Loveless MB. Supernumerary nipple presenting as a vulvar mass in an adolescent: Case report and literature review. *J Pediatr Adolesc Gynecol.* 2009;22:e41–e44.
12. Netter FH, Geschickter CF. Anatomy and pathology of the mammary gland. In: Netter FN, Oppenheimer E, eds. *The CIBA Collection of Medical Illustrations.* Vol. 2. Rochester, NY: The Case-Hoyt Corporation; 1977:250.
13. Cunningham MD, Acker D. *Animal Science and Industry.* Hoboken, NJ: Pearson Prentice Hall; 2005.
14. Teplica D. Discussion: Autologous fat grafting and injectable dermal fillers for human immunodeficiency virus-associated facial lipodystrophy: A comparison of safety, efficacy, and long-term treatment outcomes. *Plast Reconstr Surg.* 2013;131:507–509.
15. Teplica D. Recapturing science in clinical photography. *J Biocommun.* 2009;35:E31–E32.

16. Teplica D. The genetic basis of body shape: Lessons from mirror twins and high-definition digital photography. *Virtual Mentor.* 2010;12:412–417.
17. Teplica D, Schuleman D, Masri V. Scientific documentation of the human body using highly standardized rotational photography. *J BioCommun.* 2020;2:7–19.
18. Bank J, Teplica D. Anatomy of flank adipose: The Y configuration and hip extension and their effects on the perception of gender. *Plast Reconstr Surg.* 2020;146:836e–838e.
19. Teplica D, Cooney E, Kirklys M, et al. Cartography and topographic mapping: The historical basis for the standardization of anatomic analysis and surgical mark making to improve outcomes in body contouring. *Plast Reconstr Surg.* 2021;147 (in press).
20. Lambert D, Peterson B, Terpenning I. Nondetects, detection limits, and the probability of detection. *J Am Stat Assoc.* 1991;86:266–277.
21. Lorenz E, Jenkner C, Sauerbrei W, et al. Modeling variables with a spike at zero: Examples and practical recommendations in practice of epidemiology. *Am. J. Epidemiol.* 2017;185:650–660.
22. Lachin JM, Bebu I, Braffett B. Models to assess the association of a semiquantitative exposure with outcomes. *Am J Epidemiol.* 2020;189:1573–1582.
23. Arey LB. *Developmental Anatomy: A Textbook and Laboratory Manual of Embryology.* 5th ed. Philadelphia, Pa.: WB Saunders Company; 1948.
24. Schwartz S. *Principles of Surgery.* 4th ed. New York: McGraw-Hill; 1984:523.
25. Babuccu O, Kalayci M, Turhan E, et al. Mammae erraticae: A case report and reappraisal of the related theories. *Aesthetic Plast Surg.* 2012;36:607–610.
26. Bank J. Management of ectopic breast tissue. *Aesthetic Plast Surg.* 2013;37:750–751.
27. Katch VL, Campaigne B, Freedson P, et al. Contribution of breast volume and weight to body fat distribution in females. *Am J Phys Anthropol.* 1980;53:93–100.
28. Teplica D, Bohorquez M, Podbielski FJ. Morcellized omental transfer for severe HIV facial wasting. *Plast Reconstr Surg Glob Open.* 2013;1:e73.