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Assessment of vascularity with color Doppler ultrasound in gynecomastia

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PURPOSE
The aim of this study was to analyze the presence and type of vascularity with color Doppler ultrasound (CDUS) in gynecomastia, to describe gray-scale ultrasound (US) and CDUS features in different stages of gynecomastia, and to compare these findings with the characteristic US appearances of Tanner stages.

MATERIALS AND METHODS
A total of 108 breasts of 54 males aged 11–27 years with complaint of gynecomastia and US verification of gynecomastia were evaluated. Each breast was then classified according to Tanner stages. The retroareolar thickness was measured. The breast was divided into three regions (medial, lateral, and retroareolar) and the arterial flow was scored according to the number of regions in which arterial flow was observed. Venous blood flow was scored according to the number of vessels in each breast.

RESULTS
Gynecomastia was present in 78 breasts with a retroareolar thickness of 5–31 mm and symptom duration of 1–300 weeks. Fifteen breasts with gynecomastia had no arterial or venous flow. Tanner stages were found to be strongly associated with arterial and venous flow scores, duration of symptoms, and retroareolar thickness ($P < 0.001$).

CONCLUSION
This study shows that vascular structures should be accepted as a component of gynecomastia. Vascularity in gynecomastia corresponds to progression of breast development, and as the process advances vascularity becomes more prominent.

Key words: • *breast diseases* • *gynecomastia* • *male* • *ultrasonography*

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The normal male breast consists of fatty and fibrous tissue with retroareolar duct-like structures (1). However, disturbance of the estrogen-androgen balance in males leads to visually noticeable and palpable breast growth, described as gynecomastia. In early gynecomastia, there is initially ductal proliferation and formation of a vascular surrounding connective tissue stroma. The ductal system becomes less prominent as fibrosis and hyalinization increase with further progression (2). Typically, lobular development with the formation of acini does not occur in gynecomastia, and the progression of this histopathology proceeds regardless of the etiology (3, 4).

Once gynecomastia is diagnosed, the Tanner grading system is used to describe the stage of breast development (Table 1); this system is a clinical classification representing the structural changes related to breast development stages (5–7). Tanner staging can be correlated with characteristic ultrasound (US) appearances, which depend on histological changes in the breast, including branching ducts and adipose tissue (6). The vessels are also part of the breast structure, and their evaluation in gynecomastia may be as important as evaluating the ducts or adipose tissue.

Our aim was to analyze the presence and type of vascularity in gynecomastia with color Doppler US (CDUS), to describe gray-scale US and CDUS features in different stages of gynecomastia, and to compare these findings with the characteristic US appearances of the Tanner stages.

Materials and methods

The participants of this prospective study gave informed consent before ultrasonographic examinations, and the study had the approval of our institutional review board.

Male patients undergoing breast US at our tertiary care hospital between December 2005 and January 2007 for various breast symptoms were included in this study. Patients with pathological gynecomastia which is associated with a chromosomal disorder (e.g., Klinefelter syndrome), underlying disease (e.g., testicular tumor, hyperthyroidism), or breast mass detected by gray-scale US were excluded from the study (3). The study population consisted of 54 male patients with complaint of breast enlargement or pain (range, 11–27 years; mean age, 16.2 years). Both breasts of all patients were scanned in order to depict bilateral gynecomastia. A total of 108 breasts of 54 males were examined with gray-scale US and CDUS by the same senior radiologist.

A CDUS scanner (SDU-2200; Shimadzu Corporation, Kyoto, Japan) equipped with an 8 to 10 MHz linear transducer was used. Gray-scale US and CDUS examinations were performed in the supine position. CDUS was performed with low flow settings: low velocity scale (velocity, 3.8–7.7 cm/s; pulse repetition frequency, 250–500 Hz), low wall filter (6.7–10

Table 1. Tanner stages of breast development and the characteristic gray-scale US findings of the Tanner classification

Clinical Tanner classification (1)		Gray-scale US findings (3)
Tanner I	(Preadolescent) No breast tissue	Ill-defined hyperechoic retroareolar tissue
Tanner II	Areolar enlargement with palpable retroareolar bud development	Hyperechoic retroareolar nodule with a central scar-shaped or linear hypoechoic area
Tanner III	Enlargement and elevation of the entire breast	Hyperechoic glandular tissue is seen extending away from the retroareolar area and a central spider shaped hypoechoic region is noted
Tanner IV	Projection of the nipple and areola above the breast tissue	Hyperechoic, mostly periareolar, fibroglandular tissue is seen, showing a prominent hypoechoic nodule in the central region
Tanner V	Regression of the areola to form a smooth contour with the rest of the breast tissue	Hyperechoic glandular tissue is found, with increased subcutaneous adipose tissue anteriorly and without the hypoechoic central nodule seen in Tanner stages II, III and IV

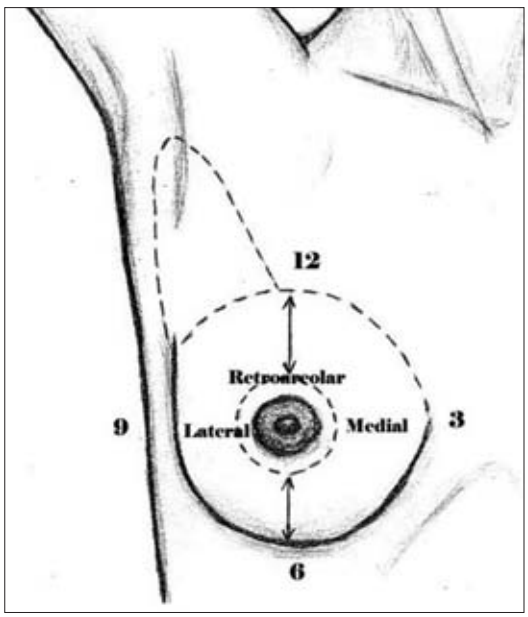

Figure 1. Diagram demonstrating the regional classification for using arterial flow score.

Hz), and a sample volume of generally 1 mm^3. Color gain was adjusted dynamically to maximize depiction of blood vessels while avoiding artifactual color noise.

The following parameters were evaluated: number of breasts with gynecomastia, duration of symptoms, retroareolar glandular thickness, sonographic Tanner staging, presence of vascularity, arterial flow, arterial flow score, and venous flow score.

The presence of gynecomastia was evaluated with gray-scale US after excluding breast masses. The duration of the patient's symptoms was recorded. The retroareolar glandular thickness between the areola and the pectoral fascia was measured at the level of its maximum width. Gray-scale US findings were used for staging according to the sonographic characteristic findings described by Garcia et al. (based on the Tanner classification; Table 1) (7). Vascular structures were evaluated when CDUS revealed some vascular flow in the breast. Spectral Doppler US was used for differentiating arterial and/or venous nature of the flow if any vessels were seen. The whole breast was divided into three regions (medial, lateral, and retroareolar) to evaluate arterial flow by CDUS (Fig. 1). The resistive index (RI) was measured in each region. Arterial flow was scored according to the number of regions in which arterial flow was observed: 0 = no arterial flow, 1 = arterial flow seen in 1 region, 2 = arterial flow seen in 2 regions, 3 = arterial flow seen in 3 regions. When a vein was observed in the breast, the venous flow was scored according to the number of vessels in each breast: 0 = no venous flow, 1= venous flow in 1 or 2 veins, 2 = venous flow in more than 2 veins.

The SPSS (Statistical Package for Social Sciences) version 11.5 statistical package for Windows (SPSS Inc., Chicago, USA) was used for statistical analysis. Spearman comparison test was used to analyze the correlation between the Tanner stages using sonography and the duration of the symptoms, retroareolar glandular thickness, arterial flow score, and venous score.

Table 2. Median (minimum–maximum) retroareaolar thickness and duration of symptoms in the presence and absence of vascularity

	Retroareolar thickness (mm)	Duration of symptoms (weeks)
Vascularity (-)	11 (5–19)	2 (1–50)
Vascularity (+)	18 (6–31)	16 (3–300)

Results

Gynecomastia was found in 78 of 108 breasts by US examination. In all patients, asymptomatic breasts were also normal sonographically. Thirty cases (56%) were unilateral and 24 cases (44%) were bilateral. The duration of patient symptoms varied from 1 week to 300 weeks (median, 10 weeks) (Table 2).

The retroareolar thickness was 5–31 mm (median, 20 mm).

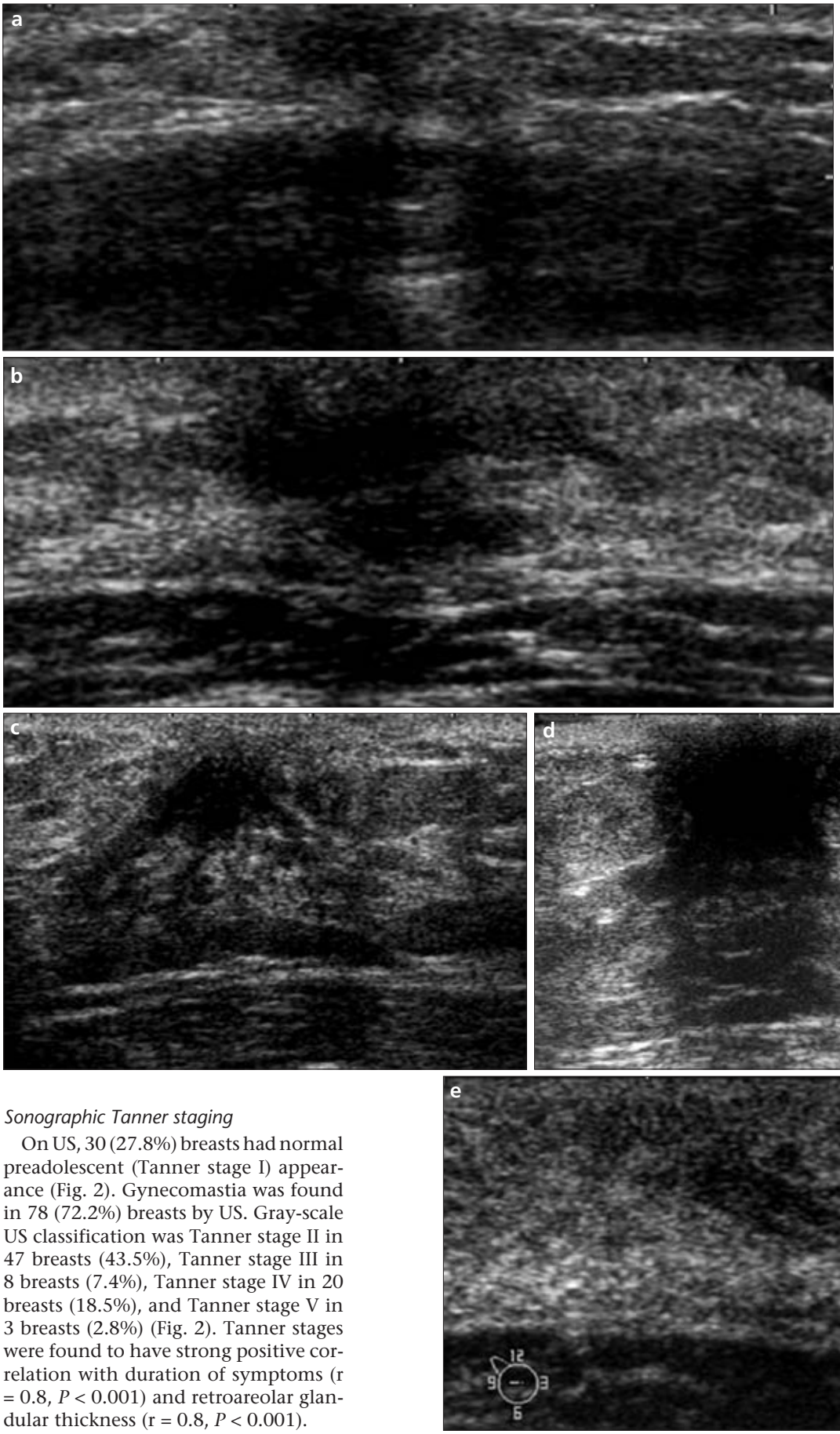

Figure 2. a–e. US images of five Tanner stages. Stage I **(a)**, stage II **(b)**, stage III **(c)**, stage IV **(d)**, and stage V **(e)**.

Sonographic Tanner staging

On US, 30 (27.8%) breasts had normal preadolescent (Tanner stage I) appearance (Fig. 2). Gynecomastia was found in 78 (72.2%) breasts by US. Gray-scale US classification was Tanner stage II in 47 breasts (43.5%), Tanner stage III in 8 breasts (7.4%), Tanner stage IV in 20 breasts (18.5%), and Tanner stage V in 3 breasts (2.8%) (Fig. 2). Tanner stages were found to have strong positive correlation with duration of symptoms (r = 0.8, $P < 0.001$) and retroareolar glandular thickness (r = 0.8, $P < 0.001$).

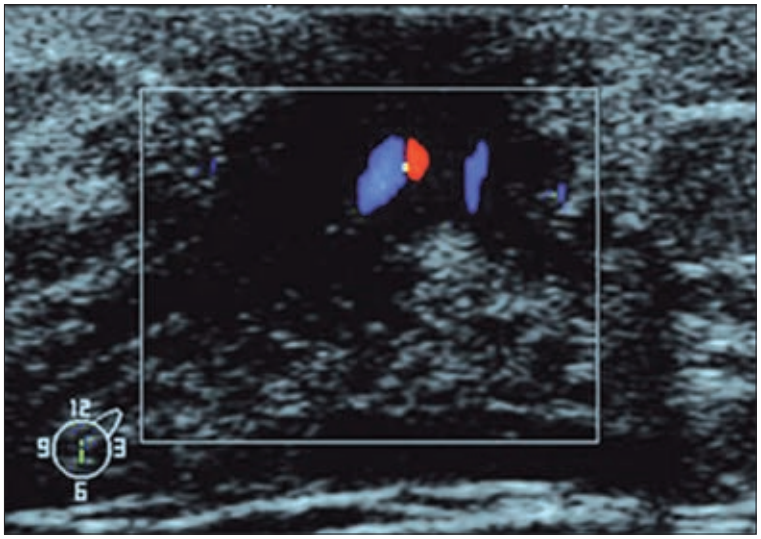

Figure 3. CDUS image showing the vascularity in the retroareolar region of a 26-year-old male patient with a symptom duration of 22 weeks. Tanner stage, III; arterial score, 2; and venous score, 2.

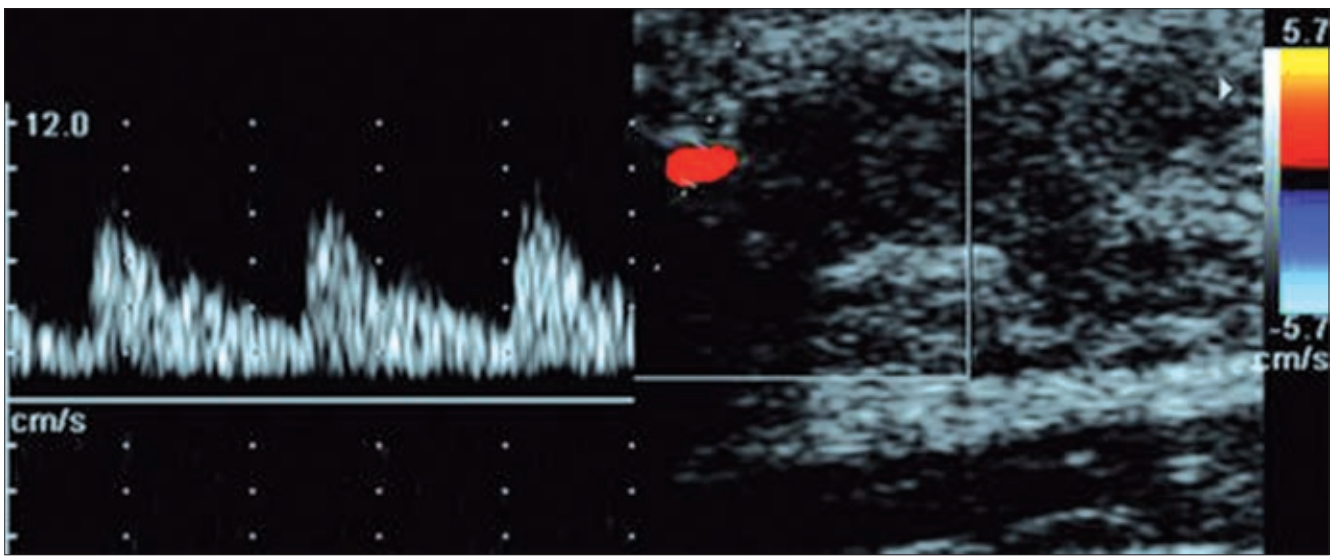

Figure 4. CDUS image showing the presence of arterial flow within the breast of a 17-year-old male patient with symptom duration of 8 weeks. Tanner stage, II; arterial score, 2.

Table 3. Distribution of the arterial flow scores according to the Tanner classification

Arterial score	Tanner II (n = 47)	Tanner III (n = 8)	Tanner IV (n = 20)	Tanner V (n = 3)	Total
0	15	-	-	-	15 (19%)
1	18	1	1	1	21 (27%)
2	14	4	4	-	22 (28%)
3	-	3	15	2	20 (26%)

Presence of vascularity

Vascularity was present in 63 (81%) breasts with gynecomastia and was absent in 15 (19%; Fig. 3). All breasts with no vascularity were Tanner stage II. Correlation of vascularity with duration of symptoms and with tissue thickness is shown in Table 2.

Arterial flow

Arterial flow was present in 63 (81%) breasts (Fig. 4). Arterial flow was most commonly found at the retroareolar (n = 54) and lateral regions (n = 42) of the breast and was relatively less common at the medial region (n = 29). Mean RI values were 0.61 ± 0.076 in the retroareolar region, 0.63 ± 0.066 in the medial region, and 0.63 ± 0.074 in the lateral region.

Arterial flow score

Arterial flow was scored according to the number of regions with arterial flow and is presented in Table 3.

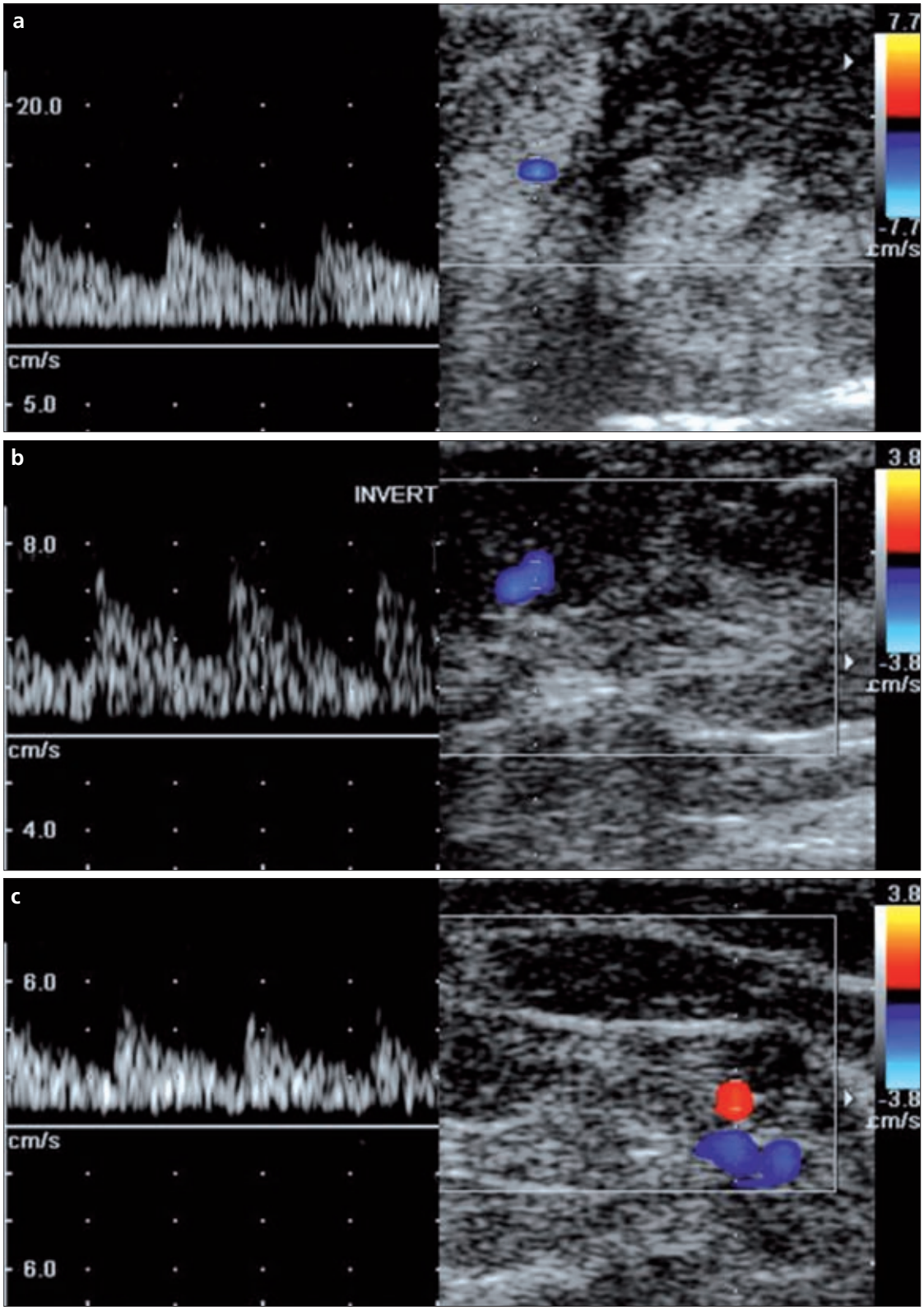

Figure 5. a–c. CDUS images of a 15-year-old male patient with gynecomastia symptoms for 82 weeks with an arterial score of 3, venous score of 2, and a Tanner stage of IV. The retroareolar **(a)**, lateral **(b)**, and medial **(c)** regions of the breast.

The lower arterial scores (0 and 1) were found most commonly in Tanner stage II. The highest arterial score (score 3) was only seen in Tanner stages III, IV, and V (Fig. 5). Consequently, there was a strong positive correlation between the arterial flow scores and Tanner stages (r = 0.8, $P < 0.001$). The arterial flow scores strongly correlated with duration of symptoms (r = 0.8, $P < 0.001$) and retroareolar glandular thickness (r = 0.8, $P < 0.001$).

Venous flow score

Venous flow was present in 22 of 78 (28%) breasts (Fig. 6) and absent in 56 (72%). Table 4 presents the distribution of the venous flow score by Tanner classification in 78 breasts. The

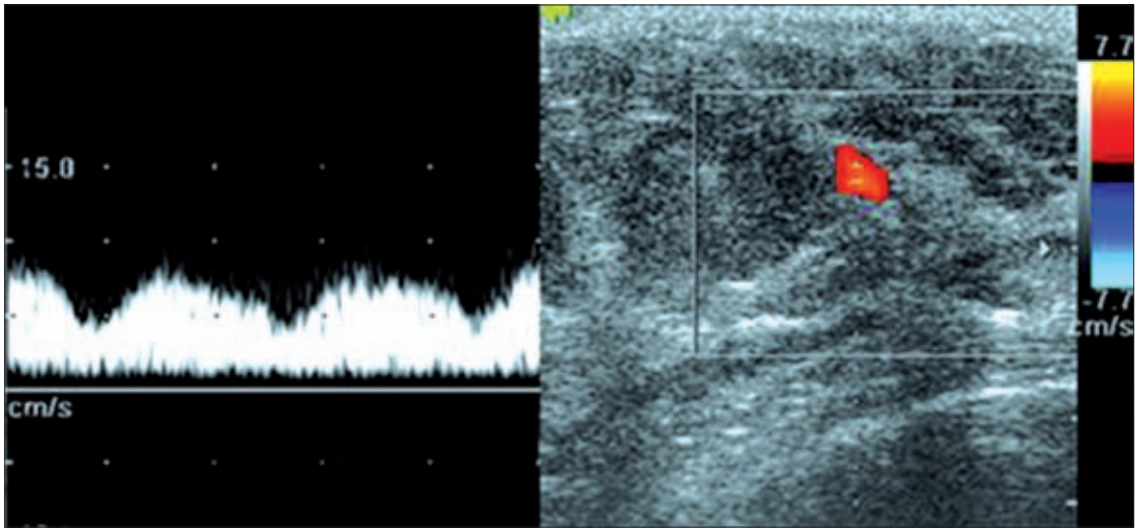

Figure 6. CDUS image showing the presence of venous flow within the breast of a 17-year-old male patient with a symptom duration of 104 weeks. Tanner stage, V; venous score, 1.

Table 4. Distribution of the venous flow scores according to the Tanner classification

Venous flow score	Tanner II (n = 47)	Tanner III (n = 8)	Tanner IV (n = 20)	Tanner V (n = 3)	Total
0	44	4	8	-	56 (72%)
1	3	1	7	2	13 (17%)
2	-	3	5	1	9 (11%)

low venous flow scores were most commonly found in Tanner stage II, while higher venous flow score (score 2) was only seen in Tanner stages III, IV, and V. Consequently, a strong positive correlation was found between venous flow scores and Tanner stages (r = 0.6, $P < 0.001$). Venous flow scores were associated with duration of symptoms (r = 0.5, $P < 0.001$) and retroareolar glandular thickness (r = 0.5, $P < 0.001$).

When the vascular scores were evaluated together, there was strong positive correlation between arterial/venous flow scores and Tanner stages (r = 0.6, $P < 0.001$).

Discussion

Gynecomastia is defined as transient, excessive development of breast tissue in males presenting as a firm disc of tissue underlying the nipple. The etiology is usually postulated as an imbalance between estrogen and androgen. Physiologic gynecomastia most commonly occurs in three groups of patients: neonates, pubertal adolescents, and the elderly. It lasts a few months in the majority of individuals (2, 7, 8). In most cases, gynecomastia is a benign finding; however, it can be associated with pathological processes such as testicular tumors or hyperthyroidism. Most of these disorders can be excluded with a thorough history and physical examination. Laboratory evaluation is not necessary in the vast majority of boys presenting with gynecomastia (3).

Gynecomastia is bilateral in most cases, although breast development occurs on one side at first, and bilateral development becomes apparent after a few months in some cases. Unilateral gynecomastia cases (n = 30) were seen more commonly than bilateral cases in our study, perhaps due to the short duration of symptoms (as short as one week in some).

The criteria for diagnosis of gynecomastia may vary; most authors feel that a disc of breast tissue at least 2 cm in diameter is required for diagnosis (9, 10), whereas others claim that the presence of even 0.5 cm of breast tissue is sufficient for diagnosis (11). We measured the maximum distance between the skin and pectoral fascia behind the areola. The results showed that the minimum retroareolar glandular thickness was 0.5 cm in the breasts with gynecomastia and that this value increased proportionally with Tanner stage and breast vascularity.

The fibroglandular tissue is usually firm on physical examination although it may blend into the surrounding tissues, making differentiation from adipose tissue difficult. Gray-scale US is therefore the most important diagnostic tool (7, 12) and the method of choice for confirming the presence of breast tissue and characterizing abnormalities (6).

The normal male breast is seen as subcutaneous tissue with linear planes of pectoral muscle posteriorly on US (5, 7). In our assessment of vascular composition, we did not find vascularity in this preadolescent stage breast. The sonographic characteristics of gynecomastia are similar to the early breast development in female adolescents and depend on the duration of development. In early gynecomastia, the breast bud is known to appear as retroareolar tissue that is hypoechoic relative to adipose tissue on US (5, 7). When we evaluated the vascular composition, we found that some vascularity, especially arterial flow with low scores, can be seen in the earlier Tanner stages. With further progression of gynecomastia (Tanner stages III, IV, and V), this dense fibrous tissue is seen as periareolar tissue hyperechoic relative to the adipose tissue on US (7). We found that there was prominent vascularity, both arterial and venous, with higher scores in these stages (Tables 3,

4). We found that the retroareolar region was the most vascular area (69%), followed by the lateral region (54%), indicating that arterial flow development parallels glandular tissue development in the breast.

US can reveal histological changes in this manner, and characteristic sonographic findings for the classification of gynecomastia (Table 1) have been reported (7). However, this sonographic classification with gray-scale US data does not take into consideration the vascular structures of the breast. To the best of our knowledge, this is the first study evaluating the presence and pattern of gynecomastia vascularity according to the Tanner stages by CDUS. Although the breast is reported to be rich in vascular structures histologically at an early stage (1), we were unable to demonstrate this by CDUS; in our study group, 15 of 47 Tanner stage II breasts showed no vascularity. Additionally the presence and scores of vascular structures increased with the symptom duration in our study.

In the literature, the mean RI in the premenopausal women (0.64) was lower than the value for postmenopausal women (0.70), and it was reported that this difference is related to high metabolic activity of the young breast (13). Mean RI value of our patients with gynecomastia was found to be similar to that of premenopasual women (0.61–0.63); we think that this may be due to the high metabolic activity. However, RI value could not be compared with the Tanner stages because of the low number of subjects with gynecomastia of each stage.

Gynecomastia begins approximately one year after the onset of puberty and lasts only a few months (sometimes 2 years) in the majority of individuals (2, 7, 8). A spontaneous resolution of gynecomastia can be expected once the diagnosis is made. However, gynecomastia associated with large breasts (Tanner stage III or IV, or larger than 4 cm) and history of gynecomastia for longer than two years is unlikely to resolve fully spontaneously because of the development of stromal fibrous tissue (1, 8). The potential effect of vascularity in the spontaneous resolution of gynecomastia has not been investigated. In this study, our aim was to detect and describe the vascularity in gynecomastia. We did not correlate vascularity with spontaneous resolution or development of higher Tanner stages because of the lack of long-term follow-up of our patients. Evaluating this correlation with further studies could provide an indicator regarding eventual progression and regression.

One limitation of this study was the lack of pathology correlation of breasts with gynecomastia. We could have used pathology investigation to confirm the accuracy of the pathology grade and vascularity of the gynecomastia detected by sonography. Because surgical treatment of physiologic gynecomastia is not usually required, our US and CDUS findings could not be compared with pathologic findings. Another limitation was that only patients with physiological gynecomastia were included in the study. Evaluating breast vascularity with study groups that include pathological gynecomastia patients may be helpful in demonstrating the effect of physiological and pathological gynecomastia on vascularity. A third limitation was that US and CDUS were performed by a single radiologist. Having at least two experienced radiologists perform the CDUS and determining interobserver difference statistically would increase the value of the study.

In conclusion, although the sonographic diagnosis and staging of gynecomastia is done according to the evaluation of ducts and adipose and fibrous tissue content of the breast, this study shows that vascular structures should also be taken into consideration as an important component of gynecomastia. The vascularity in gynecomastia corresponds to the progression of the breast development, and as the process advances, the vascularity becomes more prominent.

References

1. Stewart RA, Howlett DC, Hearn FJ. Pictoral review: the imaging of male breast disease. Clin Radiol 1997; 52:739–744.
2. Greydanus DE, Matytsina L, Gains M. Breast disorders in children and adolescents. Prim Care 2006; 33:455–502.
3. Rahhal SN, Fuqua JS. Gynecomastia. In: Pescovitz OH, Walvoord EC, eds. When puberty is precocious. Scientific and clinical aspects. 1th ed. Totowa, New Jersey: Humana Press, 2007; 189–214.
4. Harigopal M, Murray MP, Rosen PP, Shin SJ. Prepubertal gynecomastia with lobular differentiation. Breast J 2005; 11:48–51.
5. Weinstein SP, Conant EF, Orel SG, Zuckerman JA, Bellah R. Spectrum of US findings in pediatric and adolescent patients with palpable breast masses. Radiographics 2000; 20:1613–1621.
6. Bock K, Duda VF, Hadji P, et al. Pathological breast conditions in childhood and adolescence. J Ultrasound Med 2005; 24:1347–1354.
7. Garcia CJ, Espinoza A, Dinamarca V, et al. Breast US in children and adolescents. Radiographics 2000; 20:1605–1612.
8. Hands LJ, Greenall MJ. Gynecomastia. Br J Surg 1991; 78:907–911.
9. Lucas LM, Kumar KL, Smith DL, Gynecomastia. A worrisome problem for the patient. Postgrad Med 1987; 82:73–81.
10. Niewoehner CB, Nuttall FQ. Gynecomastia in a hospitalized male population. Am J Med 1984; 77:633–638.
11. Nydick M, Bustos J, Dale JH, Rawson R. Gynecomastia in adolescent boys. JAMA 1961; 178:449–454.
12. Kronemer KA, Rhee K, Siegel MJ, Sievert L, Hildebolt CF. Gray scale sonography of breast masses in adolescent girls. J Ultrasound Med 2001; 20:491–496.
13. Rettenbacher T, Hollerweger A, Macheiner P, Gritzmann N. Color Doppler sonography of normal breasts: detectability of arterial blood vessels and typical flow patterns. Ultrasound Med Biol 1998; 24:1307–1311.