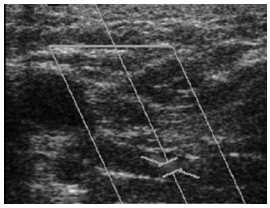

THORACODORSAL ARTERY EXAMINATION WITH DOPPLER ULTRASOUND IN HEALTHY VOLUNTEERS IN A LEVEL THREE HOSPITAL

VALORACIÓN DE LA ARTERIA TORACODORSAL CON ULTRASONIDO DOPPLER EN VOLUNTARIOS SANOS EN UN HOSPITAL DE TERCER NIVEL

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SUMMARY

Introduction: The thoracodorsal artery is a branch of the subscapular artery, which in turn is a branch of the axillary artery. The importance of this artery is that it supplies the latissimus dorsi muscle, used as a muscle-skin flap for breast reconstruction after mastectomy, mainly in patients with poor local tissues, in particular after receiving radiotherapy. *Objective:* To describe the physical characteristics of the thoracodorsal artery using Doppler ultrasound evaluation in healthy volunteers at Hospital Universitario del Valle. *Materials and methods:* We conducted a descriptive pilot study, because, after reviewing the medical literature, we did not find any reports assessing the thoracodorsal artery with the use of Doppler ultrasound. *Results:* We evaluated 51 patients, 50.9% female. The average age of the patients was 28.78 years. The axillary, subscapular and thoracodorsal arteries were identified in all patients. The characteristics of the thoracodorsal artery were as follows: diameter 1.88 mm, peak systolic velocity 28.45 cm/s, peak diastolic velocity 2.03 cm/s, resistance index 0.94, pulsatility index 4.02. Although the study did not include anthropometric measurements, we found that the artery was more conspicuous in patients with developed muscle mass and in patients with low adiposity. *Conclusions*: The thoracodorsal artery was identified in all patients, and ultrasound localization is a procedure that is easy to perform and provides vital information about the presence of the vascular pedicle required to perform a latissimus dorsi muscle-skin flap. Additional studies in postmastectomy patients are required in order to assess postoperative changes associated with the presence and physical characteristics of the thoracodorsal artery.

RESUMEN

Introducción: La arteria toracodorsal es una rama de la arteria subescapular, que a su vez es una rama de la arteria axilar. Es importante desde el punto de vista quirúrgico, pues nutre el músculo dorsal ancho, el cual se utiliza como colgajo musculocutáneo en reconstrucción mamaria posmastectomía. *Objetivo:* Describir las características cuantitativas de la arteria toracodorsal con ultrasonido Doppler en voluntarios sanos en el Hospital Universitario del Valle. *Materiales y métodos:* Se realizó un estudio observacional descriptivo piloto, ya que

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no encontramos en la literatura médica reportes de valoración de la arteria toracodorsal con ultrasonido Doppler. *Resultados:* Se evaluaron 51 pacientes (50,9% de sexo femenino). El promedio de edad en los pacientes evaluados fue 28,78 años. Las características encontradas en la arteria toracodorsal fueron: diámetro: 1,88 mm; velocidad de pico sistólico: 28,45 cm/s; velocidad pico diastólico: 2,03 cm/s; índice de resistencia: 0,94; índice pulsatilidad: 4,02. Aunque el estudio no incluía medidas antropométricas de los pacientes, la arteria se identificó más fácilmente en pacientes con masa muscular desarrollada y en pacientes con poco panículo adiposo. *Conclusiones:* La arteria toracodorsal se identificó en todos los pacientes y el examen ecográfico para su localización es un procedimiento de fácil realización, que proporciona información vital sobre la presencia de pedículo vascular indispensable para la realización de cirugía de colgajo musculocutáneo del dorsal ancho. Son necesarios estudios en pacientes mastectomizadas para evaluar los cambios posquirúrgicos, en cuanto a presencia y características físicas.

Introduction

The mammary gland is an important part of female morphology and its development is one of the most salient characteristics in gender differentiation. Breast cancer has an annual incidence of one million patients worldwide (1). Some of the breast cancer mastectomized patients —particularly those receiving chemotherapy— may develop poor quality skin and subcutaneous tissue making breast reconstruction more difficult. Hence, the *latissimus dorsi* musculocutaneous flap has been used as a reconstruction technique that contributes with good quality muscle and back skin. However, usually a prosthesis is required to achieve an adequate volume. When the patient has enough back fatty tissue, the breast reconstruction is feasible without a silicon implant (2).

The primary pedicle of the *lattisimus dorsi* is the thoracodorsal artery, a branch of the subscapular artery. The subscapular artery, the largest branch of the axillary artery usually arises from the lower margin of the subscapular muscle and advances in a posteroinferior direction (3,4). At approximately 4 cm from its origin, the axillary artery splits into the scapular circumflex artery and the thoracodorsal artery. The scapular circumflex artery, the larger of the two arteries, curves at the posterior margin of the scapula and crosses through a triangular space between the upper subscapular muscle, the greater teres below and the large head of the triceps laterally. Then it enters the infraspinatus fossa under the lesser teres and splits. The length of this branch is approximately 5 cm and the approximate diameter is 3 to 4 mm at the furcation and 2 mm distally (4). The literature reports that the subscapular artery arises from the first section of the subscapular artery only in 0.6% of the patients (5).

The thoracodorsal artery is in fact the continuation of the subscapular artery and measures approximately 12.8 cm long (4). This artery runs anteriorly to the subscapular muscles and the greater teres, laterally to the serratus anterior muscle and finally enters the *latissimus dorsi* between 6 to 12 cm from the subscapular artery and between 1 to 4 cm medially to the external margin of the muscle.

In order to successfully transpose the muscle the condition of the vascular pedicle should be appropriate. This can be assed by asking the patient to contract the muscle, which should form a posterior axillary fold. If there is still doubt despite the evaluation a pre-op Doppler ultrasound should be done. (2,6).

For the assessment of the vascular pedicle, a high-resolution ultrasound equipment is needed and 5 to 15 MHz transducers (6). The thoracodorsal pedicle gives rise to numerous branches and perforating vessels that enter the skin, and this is why the muscle can be divided into independent segments that are still viable (7).

In addition to using the *latissimus dorsi* musculocutaneous flap in reconstructive surgery, it has also been used in a surgical procedure called cardiomyoplasty in which the muscle with its intact neurovascular pedicle is transferred to the chest and wrapped around the heart (8). Bartlett et al. (9) reported in their study on fresh cadavers a low incidence of atherosclerosis of the subscapular artery (8%) and found no significant atherosclerosis of the thoracodorsal artery.

Due to the limited experience of the radiodiagnosis departments using Doppler ultrasound of the thoracodorsal artery —that can be explained on the basis of the little bibliographic information about its use, the technique applied and Doppler findings in the artery— we developed a study to assess the Doppler ultrasound characteristics of the thoracodorsal artery in healthy volunteers.

Methodology

The bibliography review did not produce any data on the standard variation of the physical characteristics of the thoracodorsal artery, and the absence of these data prevents the calculation of the sample size. Hence the decision was made to undertake an observational, descriptive, non-randomized trial as a pilot study.

51 healthy volunteers were included in the study, 18 to 60 years old. The baseline population in the study was university students and workers at a third level hospital. The following are the socio-demographical data: age (years), sex, origin, occupation, social security regime and education. Upon explaining the procedure to patients and securing the informed consent, the patients were taken to the ultrasound suite.

Patients were assessed in decubitus supine position after having some rest and with the arm of the side examined at 90° abduction. The evaluation included the bilateral axillary, subscapular and thoracodorsal arteries to determine the qualitative patency – or the absence of patency – of the vessels, the wall characteristics, diameter in millimeters (mm), systolic peak velocities and diastolic peak in centimeters per second (cm/s), resistance index and pulsatility index. The study was performed using a Siemens SONOLINE Antares™ scanner from the radio-diagnosis department of the Hospital Universitario del Valle, with a multifrequency lineal transducer preset to 10 MHz, with threshold velocity in the color Doppler scale of 28 cm/s, angle of insonation of 45°, 2 mm thick sampling box in the axillary artery. For the subscapular and thoracodorsal arteries the sampling box was preset at 1 mm.

The authors carried out the ultrasound examinations. The information obtained therefrom was collected in a form specifically designed for the trial. This information was digitalized into a database developed for the study in the Epi Info statistical package for analysis. Everyone of the variables studied was edited: the characteristics with percentages and the continued variables with averages, means, standard deviation and ranges.

Ethical Considerations

In accordance with Resolution 8430 of 1993 on Technical, Scientific and Administrative Standards for Research in Humans of the Ministry of Health at the time, this trial classifies as an over-the-minimum risk because it is a radiological study; consequently, the trial had to be revised and approved by the Ethics Committee of the Hospital Universitario del Valle and the Human Ethics Committee of the School of Health of the Universidad del Valle.

Results

51 patients were evaluated, of which 26 (50.98%) were females. The bilateral examination lasted for approximately 30 minutes per patient. The average age was 28 years (SD: 8.2) with a range from 19 to 60 years.

All patients came from Santiago de Cali. 47.06% of the patients had university degrees; 29.41% had technical education; 19.61% had completed high school education and 3.92% had completed elementary education. Out of the 51 patients, 49 (96.08%) of them are registered with the social security system and only 2% belong to the SISBEN temporary health care coverage system.

The axillary, subscapular and thoracodorsal arteries were identified in every patient evaluated. The location of the artery was accomplished with the patient in decubitus supine position, 90º arm abduction and taking into account that the subscapular artery follows a posterior inferior course (figure 1). After the emergence of the scapular circumflex artery (figure 2) it becomes the thoracodorsal artery; this finding helps for an accurate identification. It is also possible to locate the thoracodorsal artery scanning with a transducer parallel to the posterior fold of the axilla because the artery runs anteriorly to the subscapular and greater teres muscles, lateral to the serratus anterior muscle.

In the opinion of the authors, it was easier to identify the artery in patients with a large fatty layer. The values found in the axillary artery were as follows (figure 3): mean systolic pressure 84.82 cm/s (SD: 19.69), range between 47.95 and 128 cm/s; mean diastolic pressure 4.92 cm/s (SD: 3:10), range between 0.4 and 14.05; pulsatility index 4.15 (SD: 0.78), range between 2.64 and 7.11; index of resistance 0.95 (SD: 0,04), range between 0.86 and 1.02; average diameter 4.59 mm SD: 0,49), range between 3.5 and 5.65 mm.

The values found in the axillary artery of females were as follows (table 1): mean systolic pressure 87.26 cm/s (SD: 19.94), range between 54.80 and 128 cm/s; mean diastolic pressure 5.17 cm/s (SD: 3.40), range between 0.75 and 14.05; pulsatility index 4.08 (SD: 0,92), range between 2.64 and 7.11; index of resistance 0.95 (SD: 0.05), range between 0.86 and 1.02; and average diameter 4.40 mm (SD: 0.51), range between 3.5 and 5.4 mm.

Table 1. Summary of the numeric variables evaluated in the axillary artery selected by gender

	Characteristics of the Axillary Artery					
	Females (average range)			Males (average range)		
Peak systolic velocity (cm/s)	87.26	19.94	54.80 to 128.00	82.56	19.56	47.95 to 127.45
Peak diastolic velocity (cm/s)	5.17	3.40	0.75a	4.7	2.85	0.40a
Resistance Index	0.95	0.05	0.86 to 1.02	0.95	0.04	0.86 to 1.02
Pulsatility Index	4.08	0.92	2.64 to 7.11	4.24	0.63	2.91 to 5.56
Diameter (mm)	4.40	0.51	3.50 to 5.40	4.77	0.40	4.00 to 5.60

SD: Standard deviation

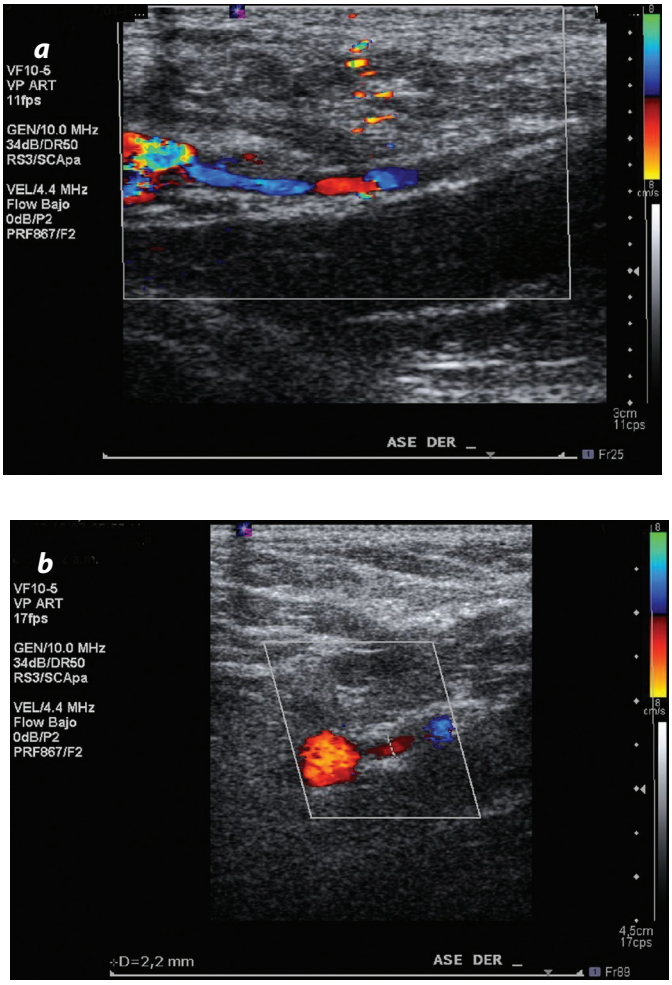

Figure 1. (a, b) Images of the outlet of the subscapular artery, branch of the axillary artery

The values found in the axillary artery in males were as follows: (table 1): mean systolic velocity of 82.49 cm/s (SD: 19.56), range between 47,95 and 127.45 cm/s; mean diastolic velocity 4,7 cm/s (SD: 2.85), range between 0.40 and 11.25; pulsatility index 4.24 (SD: 0.63), range between 2,91 and 5.56; resistance index 0.95 (SD: 0.04), range between 0,86 and 1,02; and average diameter of 4,77 mm (SD: 0.40), range between 4.0 and 5.6 mm.

The values found in the subscapular artery were as follows (figure 4): systolic velocity 40.58 cm/s (SD: 12.00), range between 20.9 and 68,05; diastolic velocity 2,01 cm/s (SD: 1,35), range between 0 and 5,15 cm/s; pulsatility index 4.39 (SD: 1.03), range between 2,13 and 6,82; resistance index 0,95 (SD: 0.05), range between 0.82 and 1.02; and diameter 2.68 mm (SD: 0.39), range between 1.79 and 3.55 mm.

The values found in the subscapular artery in males were as follows (table 2): systolic velocity 39.61 cm/s (DE: 9,52), range between 24.1 and 66.80; diastolic velocity 1.89 cm/s (SD: 1.11), range between 0.2 and 4.85 cm/s; pulsatility index 4.41 (SD: 0.86), range between 2.13 and 5.56; resistance index 0.96 (SD: 0.04), range between 0.82 and 1.02; and diameter 2.74 mm (SD: 0.40) range between 1.95 and 3.40 mm.

Table 2. Summary of the numeric variables evaluated in the subscapular artery by gender

	Characteristics of the Subscapular Artery					
	Females (average range)			Males (average range)		
Peak systolic velocity (cm/s)	41.59	14.28	20.90 to 68.05	39.61	9.52	24.10 to 66.80
Peak diastolic velocity (cm/s)	2.14	1.57	0 to 5.15	1.89	1.11	0.40 to 11.25
Resistance Index	0.95	0.05	0.86 to 1.02	0.96	0.04	0.82 to 1.02
Pulsatility Index	4.37	1.21	2.85 to 6.82	4.41	0.86	2.13 to 5.56
Diameter (mm)	2.61	0.38	1.79 to 3.55	2.74	0.40	1.95 to 3.40

SD: Standard Deviation

The values found in the subscapular artery in males were as follows (table 2): systolic velocity 39.61 cm/s (DE: 9.52), range between 24.1 and 66.80; diastolic velocity 1.89 cm/s (SD: 1.11), range between 0.2 and 4.85 cm/s; pulsatility index 4.41 (SD: 0.86), range between 2.13 and 5.56; resistance index 0.96 (SD: 0.04), range between 0.82 and 1.02; and diameter 2.74 mm (SD: 0.40) range between 1.95 and 3.40 mm.

The values found in the thoracodorsal artery were as follows (figure 5): systolic velocity 28.45 cm/s (SD: 8.74), range between 12.00 and 49.30; diastolic velocity 2.03 cm/s (SD: 1.19), range between 0.20 and 5.45 cm/s; pulsatility index 4.02 (SD: 1,05), range between 1.88 and 6.77; resistance index 0.94 (SD: 0.07), range between 0.78 and 1.12; and diameter 1.88 mm (SD: 0.27), range between 1.3 and 2.55 mm.

The values found in the thoracodorsal artery in females were as follows (table 3): systolic velocity 27.65 cm/s (SD: 10.61), range between 12.00 and 49.30; diastolic velocity 2.04 cm/s (SD: 1,24), range between 0.20 and 5.45 cm/s; pulsatility index 3.66 (SD: 0.84), range between 2.07 and 6.20; resistance index 0.93 (SD: 0.06), range between 0.78 and 1.01; and diameter 1.78 mm (SD: 0.25), range between 1.3 and 2.55 mm.

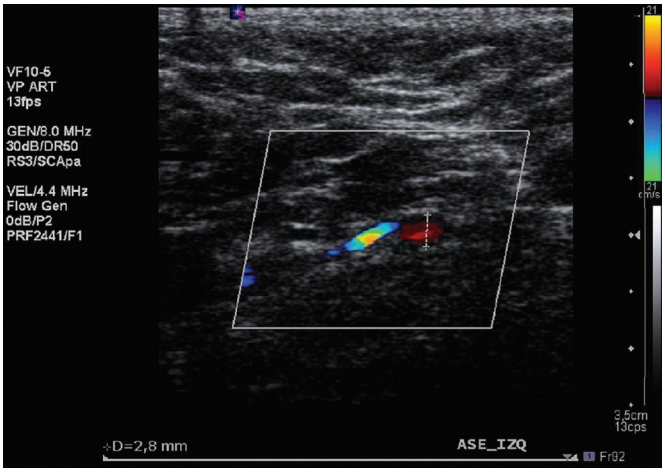

Figure 2. Scapular circumflex artery, branch of the subscapular artery

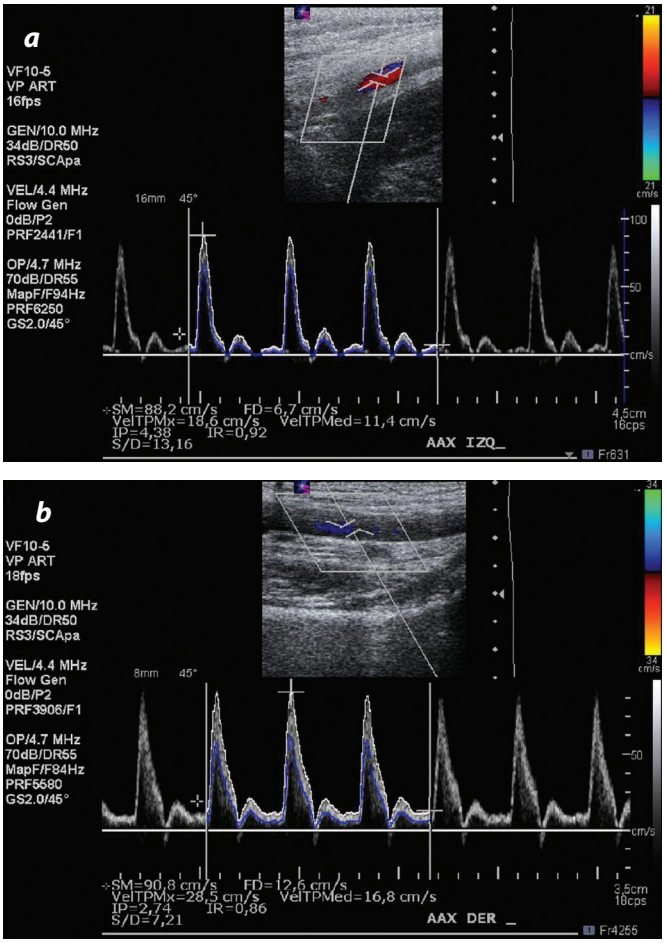

Figure 3. Triple mode Doppler ultrasound images, showing the axillary artery in a male patient (a) and in a female (b).

The values found in the thoracodorsal artery in males are as follows (table 3): systolic velocity 29.22 cm/s (SD: 6.59), range between 15.35 and 41.15; diastolic velocity, 2.02 cm/s (SD: 1.16), range between 0.50 and 4.60 cm/s; pulsatility index 4.38 (SD: 1.12), range between 1.88 and 6.77; resistance index 0.95 (SD: 0.08): range between 0.79 and 1.12; and diameter 1.97 mm (SD: 0.25), range between 1.5 and 2.45 mm.

Table 3. Summary of the numerical variables evaluated in the thoracodorsal artery selected by gender

	Characteristics of the Thoracodorsal Artery					
	Females (average range)			Males (average range)		
Peak systolic velocity (cm/s)	27.65	10.61	12.00 to 49.30	29.22	6.59	15.35 to 41.15
Peak diastolic velocity (cm/s)	2.04	1.24	0.20 to 5.45	2.02	1.16	0.50 to 4.60
Resistance Index	0.93	0.06	0.78 to 1.01	0.95	0.08	0.79 to 1.12
Pulsatility Index	3.66	0.84	2.07 to 6.20	4.38	1.12	1.88 to 6.77
Diameter (mm)	1.78	0.25	1.3 to 2.55	1.97	0.25	1.5 to 2.45

SD: Standard deviation

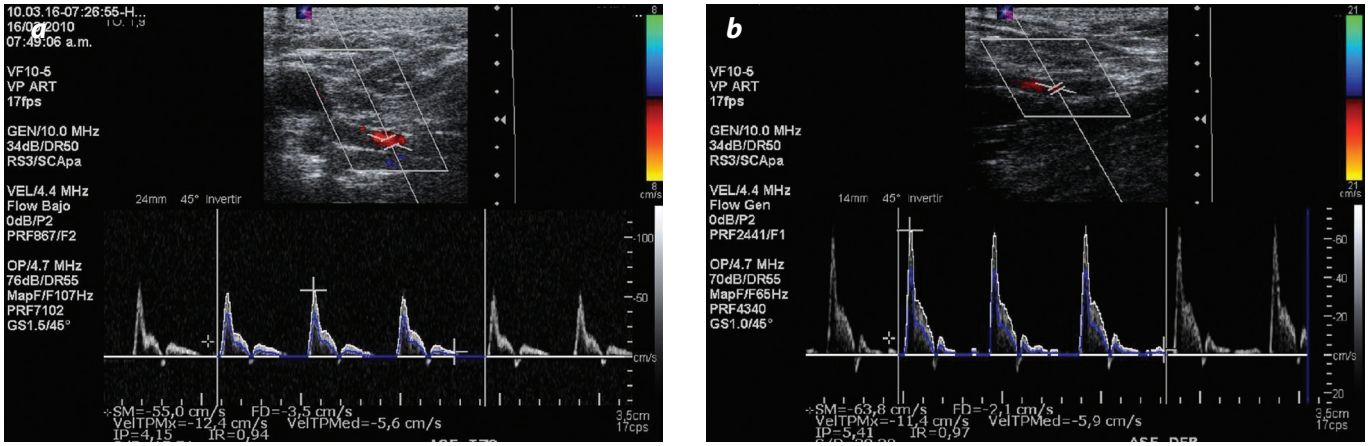

Figure 4. Triple mode Color Doppler ultrasound showing the subscapular artery in a male patient (a) and in a female (b)

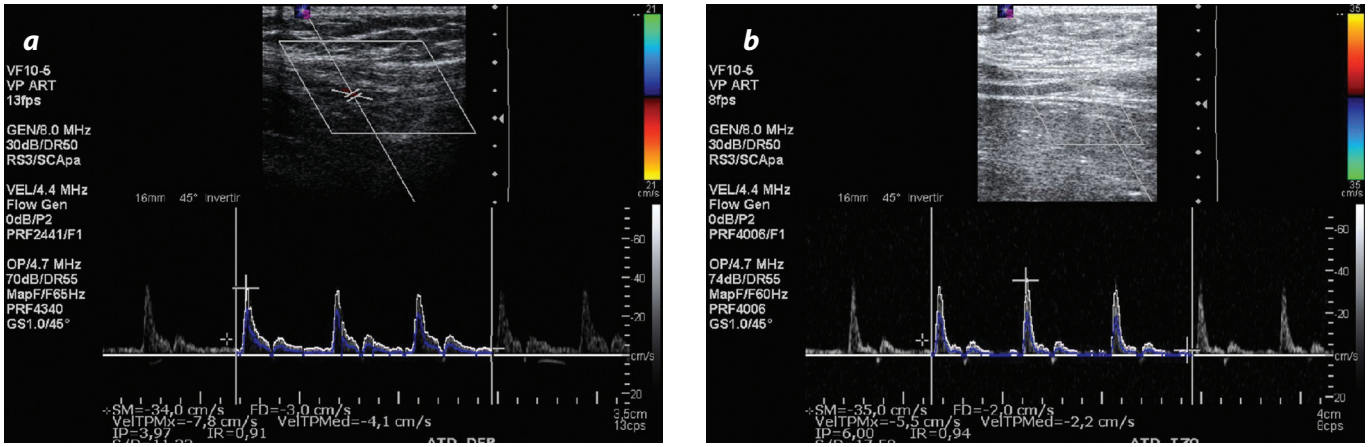

Figure 5. Triplex mode color Doppler ultrasound, showing the thoracodorsal artery in a male patient (a) and in a female (b)

The flow pattern found in the axillary, subscapular, and thoracodorsal arteries was three-phase (figures 3, 4 and 5). In some patients a broader spectrum of the thoracodorsal artery was found. None of them showed evidence of atheromatous plaques.

Discussion and conclusions

The identification of subscapular and thoracodorsal arteries in 100% of the patients is consistent with the literature reviews regarding the presence of a constant pedicle (2). We found a larger arterial diameter in male patients and hence there is a need to undertake a randomized trial to establish whether the gauge differential is statistically significant.

Similarly, a high resistance three-phase flow pattern was identified, consistent with the usual findings in muscle arteries. We believe that Doppler ultrasound of the thoracodorsal artery is a simple procedure that can be completed in an acceptable and reproducible length of time.

The peak systolic velocity data are easily obtained from the thoracodorsal artery and thus this study can be performed in patients who are candidates for mastectomy and in post-surgical follow up to determine whether the values identified are in any way related to the adequate graft fixation. This should encourage the development of additional studies in the future in this type of patients.

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