INTRAPENILE ARTERIAL ANATOMIC DETAILS EXAMINED BY COLOR DOPPLER ULTRASONOGRAPHY

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SUMMARY

As color Doppler ultrasonography evaluates penile arterial system functionally, it also reveals the anatomy of the penile arterial system. Anatomy of intrapenile arterial system has been evaluated in 54 patients suffering from erectile dysfunction between ages range of 20 to 57 (mean age: 39.15±18.52) by color Doppler ultrasonography. The anastomosis between cavernosal arteries and also the anastomosis between dorsal artery and cavernosal artery are the most commonly seen variations. The existence and number of cavernosal perforating arteries from dorsal artery should be considered in planning by-pass surgery. Further studies should be done in order to evaluate the importance of these anastomosis for a special type of impotence.

Key Words: Color Doppler ultrasonography-penis-arterial anatomy

INTRODUCTION

Pudendal pharmacoarteriography provides morphological and functional assessment of penile arterial system (1,2). However, this test is relatively invasive and the functional evaluation of the arterial supply cannot be quantified (3). Color Doppler ultrasonography is the most reliable method for the evaluation of the penile arterial inflow. Recently, flows of 2 cm/sec. can also be detected by using this technique (4). This enables the assessment of intrapenile arterial anatomy besides functional evaluation. This study analyses the variations of intrapenile arterial anatomy and the correlation of these with functional status of the arterial system in 54 men with erectile dysfunction who were evaluated in our andrology center.

MATERIALS AND METHODS

Fifty-four patients whose ages range between 20 and 54 (mean age:39.15±18.52) applied to our impotence clinic. They were evaluated by detailed sexual history, physical examination, chemistry panel, serum testosterone and prolactin levels, biothesiometry, Combined Injection of 60 mg, papaverine and Stimulation (CIS) test, color Doppler ultrasonography, cavernosometry, -graphy and nocturnal penile tumescence-NPT-(optional).

Cavernosal artery diameter was measured before intracorporeal injection of 60 mg. papaverine hydrochloride (ICP-60). The increase in diameter and cavernosal artery systolic peak blood flow velocity after ICP-60 were measured and intrapenile arterial anatomic details were evaluated by using color Doppler ultrasonography (ACUSON 128 10MHz imaging, 4.5 MHz pulsed Doppler, software version: 9.2). After evaluation of cavernosal artery diameter increased percentage and systolic peak blood flow velocity by color Doppler ultrasonography in the initial phase, penile axial rigidity was assessed afterwards by bucklometer. According to the cavernosal artery systolic peak blood flow velocity measurements using color Doppler ultrasonography penile arterial disease was classified in three subgroups namely slight, moderate and severe. The reason for this subclassification is selecting the most appropriate therapeutic modality according to the degree of arterial disease. Cavernosal artery peak blood flow velocity values >30 cm/sec. have been accepted as normal arterial system. Peak systolic blood flow velocities ranging from 25 to 29 cm/sec. are considered as slight arterial disease, 16 to 24 cm/sec. as moderate arterial disease, and <15 cm/sec. as severe arterial disease (Table I). Patients with buckling pressure less than 500 grams were accepted as showing partial erection. These patients then were asked to perform self manual genital stimulation without ejaculation for five minutes in privacy. Following this, buckling pressure was re-assessed and cavernosal artery end-diastolic blood flow velocity was determined by color Doppler ultrasonography as described by Quam (6). If the cavernosal artery end-diastolic blood flow velocity was less than 5 ml/sec., the patient was left alone for ten minutes. After, leaving the patient alone for ten minutes the quality of erection was re-evaluated by bucklometer and the cavernosal artery end-diastolic blood flow velocity measurement was repeated and the blood flow velocity more than 5 cm/sec. was taken as a venous incompetence criterion. Moreover, cavernosal artery peak blood flow velocity values less than 30 cm/sec. and end-diastolic blood flow velocity values more than 5 cm/sec. have been accepted as mixed (arterial + venous) disease.

In the evaluation of intrapenile arterial anatomy, the anastomosis of cavernosal arteries with each other (Fig.1) and/or with dorsal arteries (Fig.2) presence of dublex, bifid, occluded cavernosal arterial structures, extra and intra-penile truncus and cavernosal artery relation, anastomosis between cavernosal and urethral arteries and segmentary arterial strictures were used as parameters. Also, the sites of perforation of tunica albuginea by the anastomosis between dorsal artery and cavernosal artery was recorded.

RESULTS

The findings of intrapenile arterial anatomy by color Doppler ultrasonography after intracorporeal injection of papaverine in 54 patients with erectile dysfunction is shown in table II. The anastomosis between right and left cavernosal arteries -83.33%- (Fig.1) and also between dorsal artery and cavernosal artery -31.48%- are the most commonly seen variations (Fig. 2). The other anatomic variations of penile arteries such as intra and extrapenile truncus, bilateral or unilateral duplex cavernosal artery, bifid strictures of cavernosal artery, segmental arterial structures, occlusion of distal cavernosal artery, anastomosis between cavernosal and urethral and anastomosis between truncus and cavernosal artery were seen less than previously mentioned two anatomic variations.

The results of penile hemodynamics for each group with intrapenile arterial anatomic variation are shown in table III. Out out 45 patients who had anastomosis between right and left cavernosal arteries, 16 (35,55%) had venogenic, 19 (42.22%) had mixed -arteriogenic and venogenic- and 8 (17.77%) had arteriogenic impotence, in which a moderate arterial disease was dominant. The remaining two patients out of 45 had neurogenic impotence. In the other anatomic variation group in which anastomosis between dorsal and cavernosal arteries exists, it has been found that 3 (17.64%) patients had arteriogenic, 7 (41.17%) had venogenic and 5 (29.41%) had mixed -arteriogenic and venogenic- impotence. The remaining two patients who had anastomosis between dorsal and cavernosal arteries, had neurogenic impotence. Since, the other intrapenile arterial anatomic variations were seen less than previously mentioned two most common variations, no correlation between penile hemodynamic findings and intrapenile anatomic variations can be demonstrated.

Table I- Classification of penile arterial system according to the systolic peak blood flow velocities of cavernosal arteries in papaverine induced erection

	Peak blood flow velocity(cm/sec.)
Normal arterial system	> 30
Slight arterial disease	25 - 29
Moderate arterial disease	16 - 24
Severe arterial disease	< 15

Table II- Variations of intrapenile arterial anatomy

VARIATION	NUMBER (%)
* Anastomosis between cavernosal arteries	45 (83.33%)
* Anastomosis between dorsal and cavernosal arteries	17 (31.48%)
* Intra-penile truncus	5 (9.25%)
* Extra-penile truncus	2 (3.70%)
* Bilateral duplex cavernosal artery	3 (5.55%)
* Unilateral duplex cavernosal artery	3 (5.55%)
* Bifid structures of cavernosal artery	2 (3.70%)
* Segmentary arterial strictures	2 (3.70%)
* Occlusion of distal cavernosal artery	2 (3.70%)
* Anastomosis between cavernosal and urethral arteries	1 (1.85%)
* Anastomosis between truncus and cavernosal artery	1 (1.85%)

Table III- Penile hemodynamic results for each intrapenile arterial anatomic variation

	Arteriogenic impotence	Venogenic impotence	Mixed impotence
Anastomosis between cavernosal arteries	8 (17.77%)	16 (35.55%)	19 (42.22%)
Anastomosis between dorsal and cavernosal arteries	3 (17.64%)	7 (41.17%)	5 (29.41%)	
Intra and extra-penile truncus	1 (14.28%)	2 (28.57%)	1 (14.28%)
Accessory cavernosal artery	–	4 (50.00%)	2 (25.00%)
Occlusion of distal cavernosal artery	1 (50.00%)	–	–

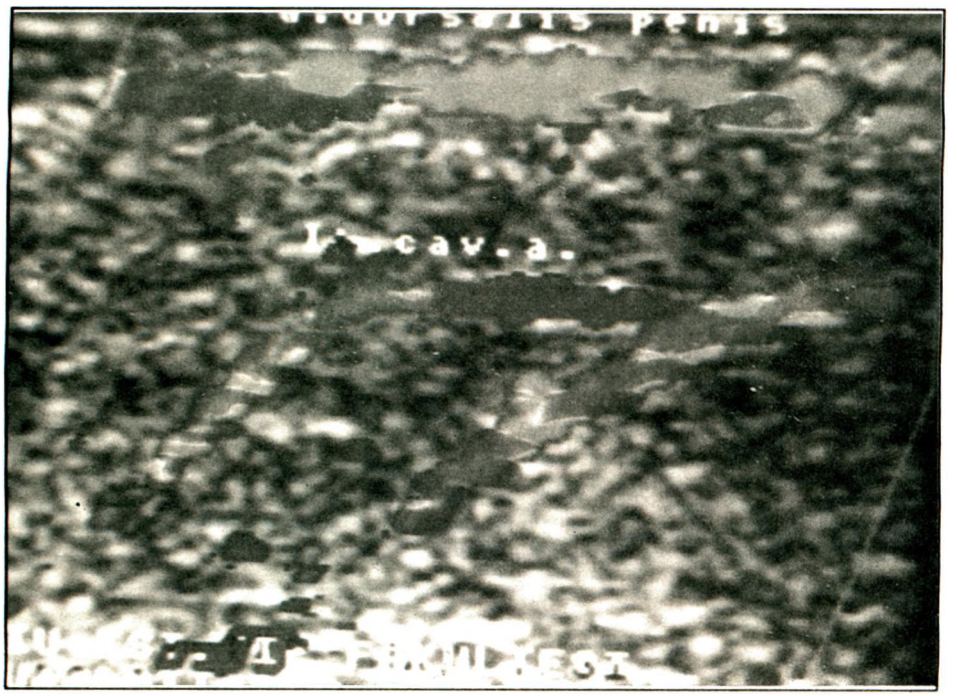

Fig 1. Two anastomoses between left and right cavernosal arteries and arteria dorsalis penis without anastomosis can be seen sharply.

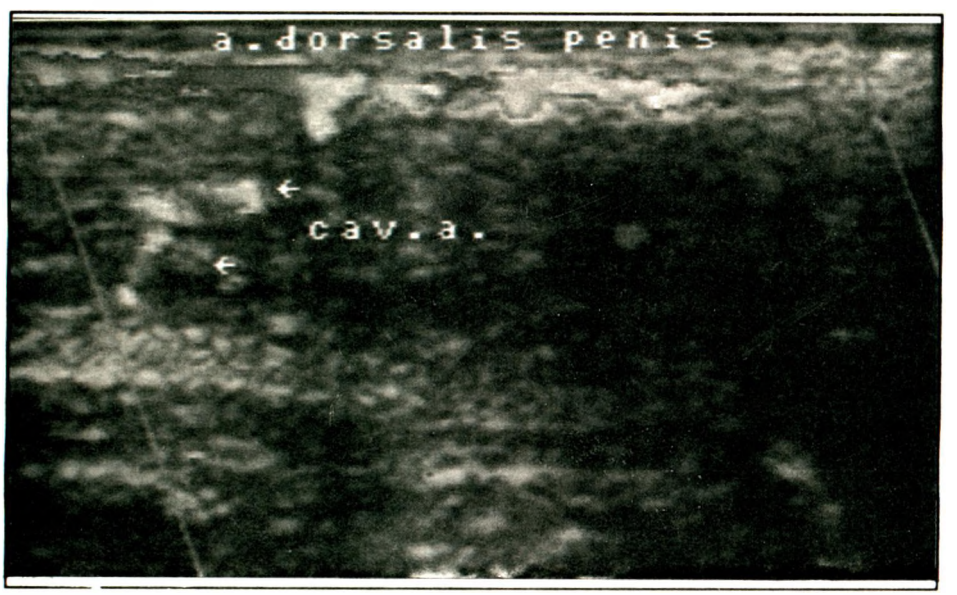

Fig 2. Anastomosis between dorsal and cavernosal arteries.

DISCUSSION

The comparison of the anatomic variations of our study with Bookstein's series (7), in which the most developed technique of pharmacoarteriography, namely penile magnification but not color Doppler ultrasonography was used, can be seen in table IV. When these findings are compared, anastomosis between both cavernosal arteries and also between dorsal and cavernosal arteries are the most commonly seen variations. In our study the number of anastomosis between dorsal and cavernosal arteries (41.83%) is less than that of Booksteins' series (91%). The reason for this could be the better visualization of dorsal arteries in pharmacoarteriography.

In the studies of Garibyan et al. in cadavers, 70 % communication rate between dorsal and cavernosal arteries has been reported (8). In the evaluation of 45 patients by color Doppler ultrasonography conducted by Benson et al. (9), 33.3% anastomosis between dorsal and cavernosal arteries has been stated. Accessory internal pudendal artery was reported 6% to 9% in angiographic studies while the occurrence is 10.9% among male specimens (10). In the assessment by color Doppler ultrasonography, an accessory internal pudendal artery can be identified as a duplex accessory cavernosal artery at the level of the penile hilum. In our series, accessory cavernosal artery has been spotted overall in 8 patients (14.51%) being bilateral in three, unilateral in three and bifid in two.

The evaluation of cavernosal arterial variations at the level of hilus penis by color Doppler ultrasonography, has advantages over penile angiographic assessment, during which exposure to x-ray, used increased amounts of contrast agents and longer time of the study are necessary. The existence and the number of cavernosal perforates from dorsal artery should be considered in planning by-pass surgery. The area of origin of a perforator should be spared and the anastomosis should be done proximally.

Out of 45 patients who had anastomosis between cavernosal arteries, 16 (35.55%) had venogenic, 19 (42.22%) had mixed -arteriogenic and venogenic- and 8 (17.77%) had arteriogenic impotence in which a moderate arterial disease was dominant. The other two patients out of 45 had neurogenic impotence. In the variation group with anastomosis between dorsal and cavernosal arteries, it has been found that 3 (17.64%) patients had arteriogenic, 7(41.17%) had venogenic and 5 (29.41%) had mixed -arteriogenic and venogenic- impotence. Two patients out of 17, who had anastomosis between dorsal and cavernosal arteries, had neurogenic impotence.

Further studies should be done in order to determine whether these anastomosis are of any importance for a special type of impotence or not.

Table IV- Comparison of our results with Bookstein's series

	Bookstein's series (%)	Our series (%)
Anastomosis between cavernosal arteries	91	83.33
Anastomosis between dorsal and cavernosal arteries	91	41.83
Intra and extra-penile truncus	13	12.96
Accessory cavernosal artery	57	14.81
Anastomosis between urethral and cavernosal arteries	13	1.83

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