

Baseline Penile Ultrasound and Color Doppler Parameters – A Comparison Between Psychogenic and Vasculogenic Erectile Dysfunction Patients

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Abstract

Background and Objectives: There are many causes of erectile dysfunction (ED) like congenital anomalies, neurological, endocrinal, pharmacological, psychological, pathological or hemodynamic. Penile doppler ultrasound provides real-time evaluation of cavernosal vascular flow dynamics. Purpose of our study was to evaluate and compare the baseline penile ultrasound and color doppler vascular parameters in patients of ED to see if there was any significant difference between patients of psychogenic and vasculogenic ED (diagnosed on post Papaverine injection color doppler) without the use of intracavernosal Papaverine injection. To best of our knowledge such detailed comparison of baseline penile ultrasound and doppler parameters have not been published in literature. **Methods:** We have prospectively studied 32 patients of ED who underwent ultrasound, and color doppler pre-and post-papaverine intracavernosal injection. Baseline pre papaverine diameters of right and left cavernosal arteries were measured on grey scale ultrasound. Peak systolic velocity (PSV), end diastolic velocity (EDV) and resistive index (RI) of right and left cavernosal arteries were measured on color doppler before and after injecting intracavernosal papaverine injection. Patients were divided into normal study group (psychogenic ED), arterial insufficiency and venous leakage groups (vasculogenic ED) on the basis of post papaverine color doppler findings. **Results:** Eighteen patients showed normal study, 11 showed arterial insufficiency and 3 patients had venous leakage on post Papaverine injection color doppler. When base line prepapaverine vascular diameters and color doppler parameters were compared statistically, no significant difference was detected between and within these study groups. We have also compared Ed duration and IIEF scores among various study groups and found statistically significant difference between and within the groups. **Conclusion:** Use of a vasoactive agent like Papaverine with color Doppler is must to diagnose the vasculogenic ED.

Keywords: Baseline, Color Doppler, Erectile Dysfunction, Penile Ultrasound, Psychogenic, Vasculogenic

1. Background and Objectives

Penile erection is a coordinated function of the nervous,

arterial, venous and sinusoidal systems. Penile erectile tissue is composed of cavernous smooth musculature and smooth muscles of arterial and arteriolar walls and

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it plays a key role in erection¹. A defect in any of these systems can give rise to erectile dysfunction (ED). Erectile Dysfunction is defined as the consistent inability to generate or maintain an erection of sufficient rigidity to perform sexual intercourse².

In the age group of 40-70 years 10% of men have complete, 17.1% have mild and 25.2% have moderate erectile dysfunction as estimated by Massachusetts Male Aging Study (MMAS). MMAS has estimated the prevalence of ED as 52% in this age group³.

There are many causes of ED like congenital anomalies, neurological, endocrinal, pharmacological, psychological, pathological or hemodynamic. Penile doppler ultrasound (US) provides real-time evaluation of cavernosal vascular flow dynamics. Color and spectral penile doppler US is a highly accurate tool for assessing patients with erectile dysfunction^{4,5}, it is a high performing noninvasive or minimally invasive imaging investigation that allows depiction of normal anatomy and macroscopic pathological abnormalities in real time and can depict functional changes in blood flow which can determine vascular cause of erectile dysfunction⁶. Hemodynamic dysfunction is responsible for most of the organic impotence and have many causes, here we are referring to the vascular causes only including arterial insufficiency (Peak systolic velocity less than 25cm/s), Venous leakage (end diastolic velocity > 5cm/s), or combined arterial insufficiency and venous leakage^{1,2} during post papaverine induced erection color doppler.

In literature, organic causes of ED are seen in 50-90% cases of which vascular cause accounts for 50-70% cases. Arteriogenic impotence accounts for about 30% cases, only venogenic impotence is found in about 15% cases. And often ED is caused by combined arteriogenic and venogenic causes¹.

Vascular cause of ED can be further classified using penile color doppler parameters as normal vascular response, arterial insufficiency, vascular leakage or combined arterial insufficiency and venous leakage. This method requires intracorporeal injection of a vasoactive substance such as papaverine hydrochloride or prostaglandin E1 alone or in combination with phentolamine (Lue and Tanagho 1987^{7,8}). Papaverine hydrochloride when injected in penile tissue causes direct smooth muscle relaxation and consequent filling of the corpora cavernosum with blood resulting in erection⁹. It may lead to persistent painful erection (priapism) in

some patients which can be treated successfully and conservatively⁸.

Purpose of our study was to evaluate and compare the baseline pre papaverine injection grey scale ultrasound and color doppler vascular parameters (diameter, peak systolic velocity, end diastolic velocity and resistive index of right and left cavernosal arteries) among the normal and abnormal post papaverine injection color doppler groups in patients presenting for evaluation of erectile dysfunction (ED) by color doppler combined with intracavernosal Papaverine injection.

2. Materials and Methods

Patients were referred from the department of Psychiatry and department of Urology to department of Radiology for color doppler evaluation of erectile dysfunction. 32 patients were enrolled who had history of ED and did not have any exclusion criteria of our study from December 2017 to December 2019.

Inclusion criteria: Patients having ED as per IIEF (International Index of Erectile Function) score ≤ 21 , and age ≥ 20 to ≤ 65 years were included in our study.

Exclusion criteria: Patients with coronary artery disease, hypospadias, epispadias, history of drug allergy, drug abuse, sickle cell anemia, bleeding disorders, taking anticoagulants, penile trauma, spinal trauma and spinal surgery were excluded from our study.

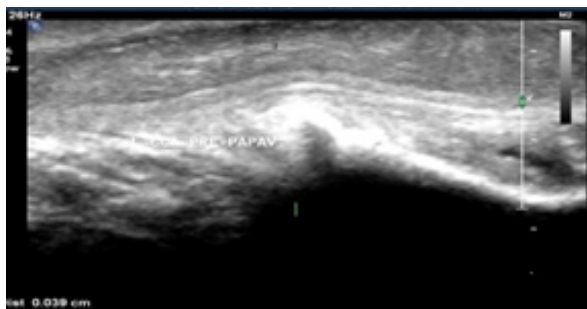
After obtaining detailed history and informed consent of the patient in an atmosphere of privacy, real time grey scale penile ultrasound and color doppler US was performed with 17-5 MHz broadband linear array high-frequency transducer on PHILIPS IU22 high resolution ultrasound machine in adequate privacy and comfortable environment. Grey scale ultrasonography was performed in axial and sagittal (Figure 1) planes to rule out any morphological abnormalities of penis and to measure the baseline prepapaverine diameters of cavernosal arteries in sagittal plane. Color doppler was performed to record the prepapaverine and post Papaverine injection peak systolic velocities (PSVs), end diastolic velocities (EDVs) and resistive indexes (RIs). Grey scale ultrasound and color Doppler US were performed in supine position of the patient with penis in anatomical position lying on the anterior abdominal wall. Diameter of cavernosal artery was measured near the base of penis where it

was maximum in caliber and was adequately visualized. Color doppler parameters were also recorded near base of penis where cavernosal arteries showed good colour filling. Papaverine 2 ml (1ml on each side, containing 30mg of the drug per ml) was injected intracavernosal using insulin syringe under all aseptic precautions and ultrasound guidance in axial scan to avoid injecting in the cavernosal artery, at mid shaft level of penis to induce erection. Colour doppler was performed at 5 minutes intervals starting from 5 minutes till 30 minutes following the papaverine injection, and PSVs, EDVs, RIs of right (R CCA) and left corpora cavernosal artery (L CCA) were recorded. Depending upon the results of post papaverine color doppler and spectral waveform analysis (**Fig.1**), patients were divided into normal study

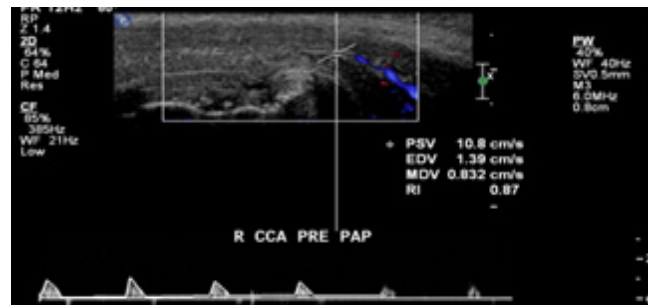
group (psychogenic ED), vasculogenic ED group (arterial insufficiency and venous leakage groups).

3. Statistical Analysis

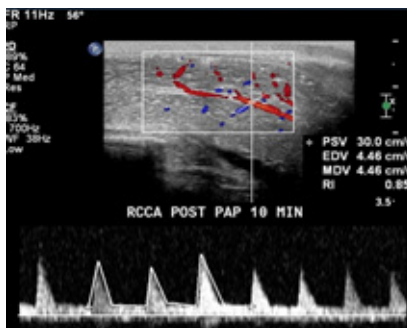
The variables were reported as numbers and percentages. The continuous data was given as mean (SD) with mean values. One way ANOVA and Tukey's HSD post hoc tests were used to compare the groups to determine any significant difference, between and within the means of two or more independent groups such as comparing the age, ED duration, IIEF score, baseline cavernosal artery diameter, color doppler parameters including PSV, EDV and RI of cavernosal artery among normal study group and vasculogenic ED groups patients. A p-value of <0.05



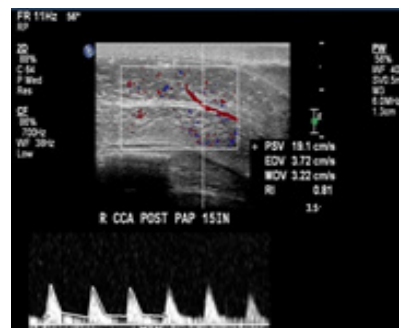
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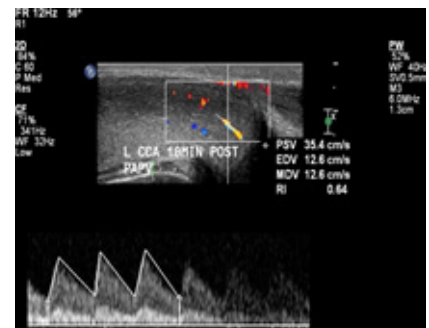
B



C



D



E

Figure 1. A -pre-papaverine (Pre-PAP) injection gray scale ultrasound (sagittal scan) showing diameter of corpora cavernosal artery diameter (white arrow), B-PSV, EDV and RI on prepapaverine (PRE-PAP) color doppler (R CCA-right corpora cavernosal artery). C, D and E -Color doppler (sagittal scans) post papaverine injection (Post-PAP) in a patient showing normal response to intra cavernosal injection at 10 minutes, in a patient with arterial insufficiency at 15 minutes and in a patient having venous leakage at 10 minutes, respectively.

was considered statistically significant. The statistical software SPSS 22.0 was used for data analysis.

4. Results

Observations regarding age, complaints with duration, marital status, comorbidities, medication/drug history, findings of greyscale ultrasonography and color doppler study were made. Statistics analysis was applied wherever applicable.

4.1 Age

Overall mean age of the patients in our study was 34.56 (9.84) years with range 31.01 – 38.11 years. It was 33.7 (10.21) years (Range: 28.09 – 38.24 years) in normal study group, 36.73(9.94) years (Range: 30.05 – 43.41 years) in arterial insufficiency group and 35.00 (8.89) years (Range: 12.92 – 57.08) years in venous leakage group. When compared age wise, there was no statistically significant difference between and within these groups ($p=0.653$) as shown in Table 2 and Table 4.

Maximum number of patients was in age group of 21-30 years i.e., 14 (43.75%). More cases ($n=30$) were of age between 21-50 years making 93.75% of total patients, and only two cases (6.25% of total) were aged between 51-65 years (Table 1).

4.2 Marital Status

In this study 20(62.50%) patients were married and 12 (37.50%) patients were unmarried. Ten married patients belonged to normal color doppler study group, 7 patients

were in arterial insufficiency group and all three venous leakage group patients were married.

Out of 10 normal Doppler study group married patients, six had two children, two had one child each and two patients did not have any child.

In arterial insufficiency group six patients had 2 children and one patient did not have any child.

In Venous leakage group one patient had no child, one had 4 children and third patient had 2 children.

Among the unmarried patients 08 belonged to normal Doppler study group and 04 patients were in arterial insufficiency group.

4.3 Duration of ED

Overall combined ED duration Mean (SD) was 8 (1.72) years with a range 2.42-5.17 years in total study group of 32 patients. Mean (SD) duration of ED was 2.02 (2.59) years in normal study group, 5.60 (3.25) years in arterial insufficiency group, and 7.83 (6.78) years in venous leakage group. ED duration was shortest in normal study group and longest in venous leakage group patients. When various groups were compared for ED duration, there was statistically significant difference between and within the groups ($p=.005$) as shown in (Table 2). Statistical analysis with Tuke's HSD test (Table 4) showed that there was significant difference of ED duration when normal group was compared with arterial insufficiency and venous leakage groups (p value .021 and .022 respectively). No statistically significant difference was seen between arterial insufficiency and venous leakage groups ($p=.553$).

Table 1. Various age group of the patients of ED in general

Age Group in years	Number of patients	Percentage (%)
21-30	14	43.75
31-40	09	28.12
41-50	07	21.88
51-60	01	3.12
61-65	01	3.12
Total	32	100

4.4 IIEF Score

As shown in Table 2, mean (SD) IIEF (International Index of Erectile Function) score in various groups was 16.41 (2.92). In normal vascular response group, mean (SD) IIEF score was 18.44 (1.72), it was 13.91(1.92) in arterial insufficiency group and 13.33 (2.88) in venous leakage group with highest mean IIEF score of 18.44 (1.72) in normal study group patients. On comparing

these means between and within the groups there was significant statistical difference ($p=.000$). When groups were compared for IIEF scores with Tukey's HSD test, there was significant difference between normal and arterial insufficiency group ($p=.000$), normal and venous leakage group ($p=.000$), but no significant difference was seen between arterial insufficiency and venous leakage group ($p=.887$). None of our patients had complete erectile dysfunction as per IIEF scores.

Table 2. Age, ED duration and IIEF score in various ED groups and comparison (ANOVA test) of these parameters between and within the groups

Parameter	N	Mean	Std. Deviation	95% Confidence Interval for Mean		Comparison	df	Mean Square	F	P value	
				Lower Bound	Upper Bound						
Age	Normal	18	33.17	10.211	28.09	38.24	Between the groups	2	43.597	.433	.653
	Arterial insufficiency	11	36.73	9.941	30.05	43.41					
	Venous leakage	3	35.00	8.888	12.92	57.08	Within the groups	29	100.644		
	Total	32	34.56	9.847	31.01	38.11					
ED Duration	Normal	18	2.0222	2.59659	.7310	3.3135	Between the groups	2	70.486	6.547	.005
	Arterial insufficiency	11	5.5909	3.24668	3.4098	7.7721					
	Venous leakage	3	7.8333	6.78847	-9.0302	24.6968	Within the groups	29	10.765		
	Total	32	3.7938	3.82339	2.4153	5.1722					
IIEF Score	Normal	18	18.44	1.723	17.59	19.30	Between the groups	2	85.849	23.934	.000
	Arterial insufficiency	11	13.91	1.921	12.62	15.20					
	Venous leakage	3	13.33	2.887	6.16	20.50	Within the groups	29	3.587		
	Total	32	16.41	2.982	15.33	17.48					

4.5 Co-Morbidity

In normal study group, 3 patients had depression, one had fracture ulna, one had fracture humerus and another patient had inguinal hernia making it to 6 (33.33%) out of 18 patients having co-morbidity.

In arterial insufficiency group no co-morbidity was seen. In venous leakage group one patient had insomnia and other patient had fracture humerus making it to 2 out of 3 patients i.e. 66.66% having co morbidity.

4.6 Medication

There was history of taking medicine -tablet Tadalafil for last 5 years in 1(5.56%) of 18 normal study group patients. In arterial insufficiency group 3 (27.27%) of 11 patients gave history of taking medicine-one patient was taking tablet Tadalafil for past 5 years, one patient was on *tablet al. prax* and third patient was taking Ayurvedic medicine for his current complaint of ED.

4.7 Grey scale Ultrasonography Findings

One of 32 (3.12%) patients, aged 47 year, showed a calcified hypoechoic plaque in right corpora cavernosa in mid shaft region suggestive of peyronie’s disease and showed normal vascular response on post Papaverine color doppler. He was not a known case of peyronie’s disease prior to his penile ultrasound and doppler study.

There was no past history of taking Papaverine or any other medication in this patient. Rest of our patients (96.97%) showed normal penile anatomy and no focal penile lesion on ultrasonography.

4.8 Baseline Vascular -Ultrasound and Color Doppler Parameters

Bilateral cavernosal arteries were better visualized near base of penis and on post Papaverine status, however in 5 (15.63%) patients visualization of these arteries took longer than usual time in prepapaverine status on grayscale as well as on color doppler US.

Baseline prepapaverine diameters of bilateral cavernosal arteries were measured on gray scale ultrasonography in sagittal scan. Pre Papaverine color doppler was performed and PSVs, EDVs and RIs of right and left cavernosal arteries (RCA and LCA) were recorded. Means of these parameters are shown in (Table 3).

Post Papaverine injection color doppler PSVs, EDVs, and RIs were recorded for right and left cavernosal arteries. Eighteen patients had normal study; 14 patients had abnormal post-Papaverine color doppler study. Out of abnormal study 14 patients -11 patients had arterial insufficiency and 03 had venous leakage.

Table 3. Baseline Prepapaverine penile vascular parameters of right and left cavernosal arteries on gray scale ultrasonography and color doppler in various groups and comparison of these parameters among various study groups by ANNOVA test

Groups (N)	Prepap-averine RCA diameter Mean (SD)	Prepap-averine LCA diameter Mean (SD)	Prepap-averine RCA PSV Mean (SD)	Prepap-averine LCA PSV Mean (SD)	Prepap-averine RCA EDV Mean (SD)	Prepap-averine LCA EDV Mean (SD)	Prepap-averine RCA RI Mean (SD)	Prepap-averine LCA RI Mean (SD)
Normal (18)	0.047 (0.002)	0.048 (0.002)	7.42(1.048)	6.79(0.750)	1.20(0.23)	1.11(0.23)	0.86(0.02)	0.84(0.03)
Arterial insufficiency (11)	0.048 (0.004)	0.051(0.003)	6.2(0.905)	7.63(2.38)	0.59(0.08)	0.79(1.71)	0.90(0.02)	0.86(0.04)
Venous leakage (3)	0.057 (0.006)	0.052(0.006)	11.78(4.261)	14.42(7.65)	1.04(0.65)	0.99(0.49)	0.89(0.09)	0.90(0.07)

Table 3 Continued

Comparison	Between groups	Within groups	Between groups	Within groups	Between groups	Within groups	Between groups	Within groups	Between groups	Within groups	Between groups	Within groups	Between groups	Within groups	Between groups	Within groups
df	2	29	2	29	2	29	2	29	2	29	2	29	2	29	2	29
Mean Square	.000	.000	.000	.000	37.189	18.447	75.145	39.562	.682	.656	.352	.731	.005	.009	.005	.018
F	1.212		0.404		2.016		1.899		1.040		0.482		0.574		0.291	
p-value	0.312		0.671		0.151		0.168		0.366		0.622		0.570		0.750	

Table 4. Comparison of age, ED duration, IIEF scores and various vascular parameters of preapaverine grey scale ultrasound and color Doppler spectral analysis among various study groups with Tukey's HSD test

Multiple Comparisons							
Tukey HSD							
Dependent Variable	(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Age	Normal	Arterial insufficiency	-3.561	3.839	.628	-13.04	5.92
		Venous leakage	-1.833	6.256	.954	-17.28	13.62
	Arterial insufficiency	Normal	3.561	3.839	.628	-5.92	13.04
		Venous leakage	1.727	6.534	.962	-14.41	17.86
	Venous leakage	Normal	1.833	6.256	.954	-13.62	17.28
		Arterial insufficiency	-1.727	6.534	.962	-17.86	14.41

Table 4 Continued

ED Duration	Normal	Arterial insufficiency	-3.56869*	1.25568	.021	-6.6698	-.4676
		Venous leakage	-5.81111*	2.04610	.022	-10.8643	-.7580
	Arterial insufficiency	Normal	3.56869*	1.25568	.021	.4676	6.6698
		Venous leakage	-2.24242	2.13708	.553	-7.5203	3.0354
	Venous leakage	Normal	5.81111*	2.04610	.022	.7580	10.8643
		Arterial insufficiency	2.24242	2.13708	.553	-3.0354	7.5203
IIEF Score	Normal	Arterial insufficiency	4.535*	.725	.000	2.75	6.33
		Venous leakage	5.111*	1.181	.000	2.19	8.03
	Arterial insufficiency	Normal	-4.535*	.725	.000	-6.33	-2.75
		Venous leakage	.576	1.234	.887	-2.47	3.62
	Venous leakage	Normal	-5.111*	1.181	.000	-8.03	-2.19
		Arterial insufficiency	-.576	1.234	.887	-3.62	2.47
Pre Papaverine Diameter RCA	Normal	Arterial insufficiency	-.001212	.003945	.949	-.01095	.00853
		Venous leakage	-.010000	.006428	.281	-.02588	.00588
	Arterial insufficiency	Normal	.001212	.003945	.949	-.00853	.01095
		Venous leakage	-.008788	.006714	.402	-.02537	.00779
	Venous leakage	Normal	.010000	.006428	.281	-.00588	.02588
		Arterial insufficiency	.008788	.006714	.402	-.00779	.02537
Pre Papaverine Dia LCA	Normal	Arterial insufficiency	-.00280	.00380	.744	-.0122	.0066
		Venous leakage	-.00417	.00620	.781	-.0195	.0111
	Arterial insufficiency	Normal	.00280	.00380	.744	-.0066	.0122
		Venous leakage	-.00136	.00647	.976	-.0173	.0146
	Venous leakage	Normal	.00417	.00620	.781	-.0111	.0195
		Arterial insufficiency	.00136	.00647	.976	-.0146	.0173

Table 4 Continued

Pre Papaverine PSV RCA	Normal	Arterial insufficiency	1.2597	1.6437	.726	-2.800	5.319
		Venous leakage	-4.3567	2.6784	.251	-10.971	2.258
	Arterial insufficiency	Normal	-1.2597	1.6437	.726	-5.319	2.800
		Venous leakage	-5.6164	2.7975	.128	-12.525	1.292
	Venous leakage	Normal	4.3567	2.6784	.251	-2.258	10.971
		Arterial insufficiency	5.6164	2.7975	.128	-1.292	12.525
Pre Papaverine PSV LCA	Normal	Arterial insufficiency	-.84480	2.40716	.935	-6.7896	5.1000
		Venous leakage	-7.63389	3.92239	.144	-17.3208	2.0530
	Arterial insufficiency	Normal	.84480	2.40716	.935	-5.1000	6.7896
		Venous leakage	-6.78909	4.09680	.239	-16.9068	3.3286
	Venous leakage	Normal	7.63389	3.92239	.144	-2.0530	17.3208
		Arterial insufficiency	6.78909	4.09680	.239	-3.3286	16.9068
Pre Papaverine EDV RCA	Normal	Arterial insufficiency	.43221	.31001	.357	-.3334	1.1978
		Venous leakage	-.01728	.50516	.999	-1.2648	1.2303
	Arterial insufficiency	Normal	-.43221	.31001	.357	-1.1978	.3334
		Venous leakage	-.44948	.52762	.674	-1.7525	.8536
	Venous leakage	Normal	.01728	.50516	.999	-1.2303	1.2648
		Arterial insufficiency	.44948	.52762	.674	-.8536	1.7525

Table 4 Continued

Pre Papaverine EDV LCA	Normal	Arterial insufficiency	.32131	.32715	.594	-.4866	1.1293
		Venous leakage	.12556	.53308	.970	-1.1910	1.4421
	Arterial insufficiency	Normal	-.32131	.32715	.594	-1.1293	.4866
		Venous leakage	-.19576	.55679	.934	-1.5708	1.1793
	Venous leakage	Normal	-.12556	.53308	.970	-1.4421	1.1910
		Arterial insufficiency	.19576	.55679	.934	-1.1793	1.5708
Pre Papaverine RI of RCA	Normal	Arterial insufficiency	-.03672	.03547	.561	-.1243	.0509
		Venous leakage	-.02944	.05780	.867	-.1722	.1133
	Arterial insufficiency	Normal	.03672	.03547	.561	-.0509	.1243
		Venous leakage	.00727	.06037	.992	-.1418	.1564
	Venous leakage	Normal	.02944	.05780	.867	-.1133	.1722
		Arterial insufficiency	-.00727	.06037	.992	-.1564	.1418
Pre Papaverine RI of LCA	Normal	Arterial insufficiency	-.01778	.05063	.934	-.1428	.1073
		Venous leakage	-.06111	.08250	.742	-.2649	.1426
	Arterial insufficiency	Normal	.01778	.05063	.934	-.1073	.1428
		Venous leakage	-.04333	.08617	.871	-.2561	.1695
	Venous leakage	Normal	.06111	.08250	.742	-.1426	.2649
		Arterial insufficiency	.04333	.08617	.871	-.1695	.2561

When multiple groups were compared by ANOVA and Tukey HSD test for various prepapaverine right and left cavernosal arterial diameters and color Doppler parameters, there was no statistically significant difference between RCA and LCA, no statistically difference was

seen between and within these groups as shown in (Table 3) above and (Table 4).

On multiple comparisons, prepapaverine diameters of right and left corpora cavernosal arteries showed no statistically significant differences was seen (Table 3 and 4 above). Similarly there was no statistically significant

difference when we compared the means of preapaverine color doppler parameters i.e. PSV, EDV and RI of various groups as shown in (Table 3 and 4).

5. Complications

Two (6.25%) of 32 patients, belonging to normal study group developed priapism and were managed conservatively. No other complications were seen our study.

6. Discussion

Erectile dysfunction (ED) is the most common sexual disorder in males with the prevalence rates of 2.59% -6% in the age between 20-29 years and prevalence of complete impotence increased from 5% to 15% in the age of 40-70 years. The prevalence of 39% at the age of 40 years, and 67% prevalence at the age of 70 years shows the association of ED with age^{10,11 and 12}.

In present study mean age (SD) of the patients presenting with ED was 34.86 (9.86) years and it varied between 21-63 years. Maximum cases were in the age group of 21-30 years. Overall maximum patients i.e., 30 (93.75%) were between 21-50 years of age, hence our results are varying from that found in literature, it might be because of relatively small sample of our study. Capogrosso P *et al.*, in 2013 studied 439 patients and found that new onset ED as primary disorder was found in 26% males younger than 40 years and at IIEF, severe ED rates were found in 48.8% younger men and 40% older men respectively ($p > 0.05$)¹³.

More of our patients were married $n=20$ (62.5%). This finding is in agreement to a study carried out by Suresh *et al.*¹⁴ in which they have reported erectile dysfunction as 70% in married and 30% in unmarried patients of total 33 patients.

Mean (SD) duration of ED was 2.02 (2.59) years in normal response group, 5.60 (3.25) years in arterial insufficiency group, and 7.83 (6.78) years in venous leakage group. When various groups were compared for ED duration, there was statistically significant difference between and within the groups ($p = .005$). Statistical analysis also showed that there was significant difference of ED duration when normal group was compared with arterial insufficiency and venous leakage groups (p value .021 and 0.022 respectively). No statistically significant

difference was seen between arterial insufficiency and venous leakage groups ($p = .553$).

The patient with organic impotence describes his problems with erection that progress over months to years, organic impotence is constant and non selective, meaning it is not better or worse with any specific partner or type of stimulation. On the other hand, psychogenic impotence is abrupt in onset, intermittent and not progressive (Ende J. 1990)¹⁵. Hence our findings of ED duration lowest in the normal study group (psychogenic ED), higher in arterial insufficiency, and highest in venous group, and statistically significant difference among the groups may be explained by the presentation of patients as described in this book to some extent.

Mean (SD) IIEF score in various groups was 16.41 (2.92). It was 18.44 (1.72) in normal study group, 13.91 (1.92) in arterial insufficiency group and, 13.33 (2.88) in venous leakage group. On comparing these means between and within the groups there was significant statistical difference ($p = .000$) with highest mean IIEF score in normal study group. Statistically significant difference was found between normal and arterial insufficiency group ($p = .000$), normal and venous leakage group ($p = .000$) but no significant difference was seen between arterial insufficiency and venous leakage groups ($p = .887$). In a study conducted by Atinbas KN *et al.* in 2018¹⁶, IIEF score was found to be 17.03 ± 3.64 , 15 ± 27 and 13.85 ± 3.24 in various groups similar to the groups of present study, hence our findings are in agreement with the finding of Atinbas KN *et al.*

The erectile dysfunction has mainly two etiologies – Psychogenic and organic. Color doppler ultrasonography is established method of evaluating the ED patients to rule out the vasculogenic organic cause. It is performed during an induced erection by papaverine/prostaglandin E1 injected in the corpora cavernosa tissue of the penis. In the present study we aimed to evaluate and compare the baseline preapaverine grey scale and color doppler vascular parameters of penis including morphological abnormalities if any, cavernosal arterial diameters, PSVs, EDVs and RIs in patients presenting with ED. Eighteen (56.25%) of 32 patients responded normally on post papaverine color doppler, hence labeled as having psychogenic ED. Rest 14 patients (43.75%) showed abnormal color doppler study indicating vasculogenic ED, out of these 11 (34.38%) patients had arterial insufficiency and 3 (9.38%) patients had venous leakage.

Organic causes of ED are seen in 50-90% cases, and vascular cause accounts for 50 -70% cases. In present study 43.75% patients had vasculogenic ED which is close to the prevalence of 50% – 70% of organic causes of ED as found in literature^{1,8,9and10}. Our study is also in agreement with a study conducted in 2017 by Usman Khanzada *et al.*¹⁷ in 97 patients where they found that 50.5% patients had normal color doppler hence psychogenic ED and 48.5% patients had vasculogenic organic cause for their erectile dysfunction.

In literature arterial insufficiency is seen in 30% cases and venous insufficiency is seen in 15% cases among the vasculogenic ED. In our study 34.38% patients had arterial insufficiency and 9.38% patients had venous leakage as cause of vasculogenic ED. Our study is in agreement with the results found in literature. Our study has found more number of arterial insufficiency cases compared to venous leakage patients and this is similar to a study conducted by Bari V *et al.*,¹⁸ which has reported a relatively large number of cases of arterial erectile dysfunction compared to venous insufficiency ED.

A study done by Gall *et al.*¹⁹ has reported accuracy of 95% in localization of penile arteries in the duplex ultrasound and high agreement (90%) in detection of vascular lesions with angiography. Moreover, duplex ultrasound may avoid the risks associated with angiography especially in arteriosclerotic patients and it also required general anesthesia and exposure to ionizing radiations. In our study we could locate the bilateral cavernosal arteries successfully on ultrasound in all 32 patients (100%) in flaccid state of penis, however it took more than usual time in locating these arteries in 5 (15.63%) patients.

Sidhu P.S. *et al.*,²⁰ have recommended that the penile ultrasound must be conducted in an atmosphere of privacy, and evaluation begins with scanning of flaccid penis shaft in transverse plane to measure the diameter of cavernosal arteries and the diameters ranged from 0.2 to 1 mm in their study.

We measured the diameters of cavernosal arteries in flaccid state in sagittal plane near base of penis and mean diameters of right and left cavernosal arteries were .047 (.00) cm and .048 (.00) cm, .048 (.00) cm and .051 (.00) cm and .057 (.01) cm and .052 (.01) cm in normal, arterial insufficiency and venous leakage groups respectively which is close to that found by Sidhu P.S. *et al.*²⁰.

Pre papaverine baseline PSVs, EDVs and RI are as shown in Table 3. We have not come across any studies showing such detailed prepapaverine baseline vascular parameters comparison among various groups. In our study when we compared these prepapaverine vascular parameters including the diameters of corpora cavernosal arteries among various groups of study, no statistically significant difference was found indicating that vasculogenic erectile dysfunction cannot be predicted by prepapaverine color doppler. Therefore, use of a vasoactive agent like papaverine combined with color doppler is essential to diagnose and classify the vasculogenic erectile dysfunction.

Priapism is a persistent erection lasting for more than 4 hours and a common and serious complication of color doppler with papaverine induced erection (Montague *et al.* 2003²¹). Its occurrence is more in patients having relatively better baseline erection dysfunction (Lomas and Jarow, 1992²²). Secil M *et al.* [2001] stated that occurrence of priapism was between 1.8-18% in various studies and recorded its incidence as 11.9% during evaluation of erectile dysfunction by color doppler and papaverine^{8,23}. In present study 2 (6.24%) patients of normal study group developed priapism and were managed conservatively. Hence use of intracavernosal papaverine is safe for color doppler ED evaluation.

Peyronie's disease is a fibrotic disease of penis causing deformity of the penis that is associated with pain, impaired ability to perform sexual intercourse, mean age at presentation is 52-57 years and estimated prevalence is 0.39-13.1% and even higher in some group of population e.g., up to 16% in post radical prostatectomy men²⁴. One (3.12%) of our 32 patients, aged 47 years, showed a calcified plaque within right corpora cavernosal parenchyma at mid shaft region on ultrasound and normal color doppler on post papaverine study. Incidence of 3.12% here is well within the incidence range shown in above study².

7. Limitations

Our study had following limitations:

Small number of patients of our study might have influenced the statistical analysis.

Penile Doppler is an operator dependant modality and might have influenced the measurements and hence analysis.

It was not a blinded study.

8. Conclusion

We conclude that routine ultrasound can show abnormal anatomical changes/pathologies of penis. Routine colour doppler ultrasonography can give assessment of normal penile vascularity, however, it cannot diagnose vasculogenic ED as no statistically significant difference was found in prepapaverine penile color doppler vascular parameters among the normal and abnormal vascular response groups which were diagnosed on post papaverine colour doppler only.

Hence, use of vasoactive agents like papaverine is must with color doppler evaluation of ED to diagnose and classify its vasculogenic cause. This will help in early diagnosis and in starting early appropriate treatment for the patients of erectile dysfunction. Priapism occurred in two of our patients on post papaverine injection which could be managed conservatively hence we conclude that papaverine use is safe for evaluation of ED patients.

We have also compared age, ED duration and IIEF in various study groups and found statistically significant difference in ED duration and IIEF score between and within the groups. ED duration was shortest in the normal doppler study group and IIEF score was highest in this group.

9. Ethical Considerations

The study was conducted on the ethical guidelines for biomedical research on human subjects as given by Central Ethics Committee on Human Research (CECHR) followed by the institutional ethic committee, and followed the tenets of "Declaration of Helinsiki.

10. Funding

None

11. Conflict of Interest

None

12. References

1. Dean RC, Lue TF. Physiology of penile erection and pathophysiology of erectile dysfunction. *Urol Clin North Am* 2005; 32: 379–80. <https://doi.org/10.1016/j.ucl.2005.08.007>
2. Juszcak K, Wyczolkowski M, Filipek M, Thor PJ. Pathophysiology of erectile dysfunction in men. *Folia Med Cracov* 2008; 49(3-4): 67–77
3. Gupta BP, Murad MH, Clifton MM, Prokop L, Nehra A, Kopecky SL. The effect of lifestyle modification and cardiovascular risk factor reduction on erectile dysfunction: a systematic review and meta-analysis. *Arch Intern Med* 14 Nov 2011; 171(20): 1797–1803. <https://doi.org/10.1001/archinternmed.2011.440>. Epub 2011 S Sep 12. PMID: 21911624
4. Bookstein JJ, Valji K, Parsons L, Kessler W. Pharmacarteriography in the evaluation of impotence. *J Urol*. Feb 1987; 137(2): 333–7. [https://doi.org/10.1016/s0022-5347\(17\)44017-1](https://doi.org/10.1016/s0022-5347(17)44017-1). PMID: 3100825.
5. Fitzgerald SW, Erickson SJ, Foley WD, Liipchik EO, Lawson TL. Color Doppler sonography in the evaluation of erectile dysfunction. *Radiographics*. Jan 1992; 12(1): 3–17: discussion 18–9. <https://doi.org/10.1148/radiographics.12.1.1734478>. PMID: 1734478.
6. Jung DC, Park SY, Lee JY. Penile Doppler Ultrasonography revisited. *Ultrasonography*. 2018 Jan;37(1): 16-24. <https://doi.org/10.14366/usg.17022>. Epub 10 Jun 2017. PMID: 28736428; PMCID: PMC5769945.
7. Lue FT, Tanagho EA. Physiology of erection and pharmacological management of impotence. *J Urol*; 1987, 137: 829–836. Google Scholar; [https://doi.org/10.1016/S0022-5347\(17\)44267-4](https://doi.org/10.1016/S0022-5347(17)44267-4).
8. M. Kilic, E.C. Serefoglu, A.T. Ozdemir, M.D. Balbay. The actual incidence of Papaverine-induced priapism in patients with erectile dysfunction following penile colour Doppler Ultrasonography. *Andrologia*. 11 January 2010. 41(2): <http://doi.org/10.1111/j.1439-0272.2009.00940.x>
9. Phani Chakaravarty Mutnuru, Harshavardhana Kuruba Ramanjaneyulu, Rammurti Susurla, Jyotsna Yarlagadda Rahul Devraj, Prabakaran Palanisamy. Pharmacologic Duplex Ultrasonography in Evaluation of Erectile Dysfunction: *J. Clin. Diagnostic Res.*, 1 Jan 2017, 11(1): TC07-TC10. <https://doi.org/10.7860/JCDR/2017/25092.9270>
10. Johannes CB, Araujo AB, Feldman HA, Derby CA, Kleinmann KP, McKinlay JB. Incidence of erectile dysfunction in men 40–90-year-old. Longitudinal Results from Massachusetts Male Aging Study. *J Urol* Feb 2000; 163(2): 460–3. PMID: 10647654. [https://doi.org/10.1016/S0022-5347\(05\)67900-1](https://doi.org/10.1016/S0022-5347(05)67900-1)

11. Feldman HA, Goldstein I, Hatzichristou DG, Krane RJ, McKinlay JB. Impotence and its medical and psychosocial correlates: results of Massachusetts Male Aging Study. *J Urol* Jan 1994; 151(1): 54–61. [https://doi.org/10.1016/s0022-5347\(17\)34871-1](https://doi.org/10.1016/s0022-5347(17)34871-1).
12. Golijanin D, Singer E, Davis R, Bhatt S, Seftel A, and Dogra V. Doppler evaluation of erectile dysfunction – Part 1. *Int. J. Impot. Res.*; Jan-Feb 2007; 19(1): 37–42. <https://doi.org/10.1038/sj.ijir.3901477>. Epub 20 Apr 2006.
13. Capogrosso P, Colicchia M, Ventimiglia E, Damiano R, Montorsi F, Salonia A et.al. One Patient Out of Four with Newly Diagnosed Erectile Dysfunction Is a Young Man- Worrisome Picture from the Everyday Clinical Practice. *J Sex Med.*: 1 July 2013; 10(7): 1833–1841. <https://doi.org/10.1111/jsm.12179>
14. Suresh A, Abishek Balachandran, N Indira, H V Ramprakash. Role of Penile Color Doppler in the Evaluation of Erectile Dysfunction. *Int. J. Sci. Study*”: October 2015; 3(7).
15. Ende J. Organic Impotence. In: Walker HK, Hall WD, Hurst JW, editors. *Clinical Methods: The History, Physical, and Laboratory Examinations*. 3rd ed. Bosten: Butterworths; 1990. Chapter 187.
16. Antinbas KN, Hamidi N. Penile Doppler ultrasonography and elastography evaluation in patients with erectile dysfunction. *Pol J Radiol*. 2018; 83: e491–499. <https://doi.org/10.5111/pjr.2018.80301>
17. Khanzada U, Khan SA, Hussain M, Adel H, Masood K, Adil SO, et al. Evaluation of the causes of erectile dysfunction in patients undergoing penile doppler Ultrasonography in Pakistan. *World J Mens Health* 2017; 35: 22–27. <https://doi.org/10.5534/wjmh.2017.35.1.22>
18. Bari V, Ahmed MN, Rafique MZ, Ashraf K, Memon WA, Usman MU. Evaluation of erectile dysfunction with color Doppler sonography. *J Pak Med Assoc* June 2006; 56(6): 258–61.
19. Gall H, Bahren W, Scherb W, Steif C, Thon W. Diagnostic accuracy of Doppler ultrasound technique of penile arteries in correlation to selective Arteriography. *Cardiovascular intervent Radiol*. 1988; 11: 225–31. <https://doi.org/10.1007/BF02577007>
20. Sidhu P.S., Wilkins C.J. (2013) Disorders of Erectile Function. In: Hamm B, Ros P.R. (eds.) *Abdominal Imaging*. Springer: Berlin, Heidelberg. 2013; p. 1911–24. https://doi.org/10.1007/978-3-642-13327-5_210
21. Montague DK, Jarow J, Broderick GA, Dmochowski RR, Heaton JP, Lue TF, et.al. American Urological Association guidelines on the management of priapism. *J Urol*. Oct 2003; 170(4pt1): 1318–24. <https://doi.org/10.1097/01.ju.0000087608.07371.ca>. PMID: 14501756
22. Lomas GM, Jarow JP. Risk factors for Papaverine –induced priapism. *J Urol*. May 1992; 147(5): 1280–1281. [https://doi.org/10.1016/S0022-5347\(17\)37542-0](https://doi.org/10.1016/S0022-5347(17)37542-0)
23. Secil M, Arslan D, Gotky Y A. Esen A A, Dicle O, Pirnar T. The prediction of Papaverine induced priapism by color Doppler sonography. *The J. Urol*. 2001; 165(2): 416– 418; DOI: 10.1097/00005392-200102000-00015
24. Bilgutay NA, Pastuszak WA. Peyronie’s disease: What’s around the bend? *Indian J Urol.*: 2016; 32(1): 6-14. <https://doi.org/10.4103/0970-1591.173107>

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