

A study on penile doppler

Introduction

Erectile dysfunction (ED) or impotence is defined as inability to achieve and/or maintain an erection for satisfactory sexual intercourse. Its prevalence increases with age and affects upto 52% men between age 40-69 years. Although erectile dysfunction(ED) does not affect life expectancy and it is not a life-threatening disorder but is associated with significant morbidity. Sex is important to men and it is important to preserve erection, orgasm and sexual desire. In a society in which sexuality is widely promoted, ED impacts on feeling of self worth and self confidence and may impair the quality of life of affected men and their partners. ED is strongly associated with unsatisfying personal experiences and relationships, highlights the association of ED with emotional and physical satisfaction with sexual partners and with feelings of general happiness.¹ Improved erectile function is accomplished by improved quality of life and decrease in general psychiatric symptoms.²

Keywords: dysfunction, decrease, symptoms, doppler sonography, vasculogenic

Aims and objectives

- To assess the role of Penile Color Doppler Sonography in the evaluation of erectile dysfunction.
- To describe the ultrasound findings of arterial and venous causes of erectile dysfunction.
- To compare IIEF-5 score among ED patients.
- To differentiate vasculogenic causes from non vasculogenic causes of erectile dysfunction.
- Association of risk factor in ED.
- Grading the ED.
- To evaluate the penile vascular function by color Doppler ultrasonography in patients with Peyronies disease.

Materials and methods

Study design: Cross sectional study.

Study period: 12months; October 2015-september 2016.

Study group: All those patients which were referred for penile color Doppler study ,in department of Radio diagnosis G.R Medical College Gwalior Madhya Pradesh.

Sample size: 52patients.

Work place: Department of Radiodiagnosis G.R.Medical College and Jayarogya Hospital,Gwalior using ALOKA PROSOUND ALPHA (Aloka Trivilion Pvt.Ltd.Tokyo Japan) USG machine with high(7.5MHz) frequency linear probe.

Inclusion criteria:

- Sexually active males of more than 18years of age

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- Duration of complaint of ED ≥ 6 months.
- Consenting to participate in the study.

Exclusion criteria

- Patients with penile implant.
- Patients with Multiple myeloma, leukaemia, AV Block.
- Patients with previous history of priapism by intracavernosal papaverine injection.
- The severity of ED was evaluated using IIEF-5, and was classified into 4 levels based on the scores: severe (5–7), moderate (8–11), mild to moderate (12–16), and mild (17–21).^{6,9}

Technique: The penile colour duplex examination is typically performed for either;

- Assessment of penile morphology for clinical indications such as penile trauma, lumps, infection or when there is suspicion of Peyronies disease and/or
- Erectile Dysfunction. This requires an intracavernosal injection of a pharmacostimulant⁷⁰ and is typically indicated after there has been equivocal or abnormal response to oral pharmacological agents (PDE-5 inhibitors).

The examination

Pre Injection: 2.1.1. The examination should be performed in a quiet relaxed environment free of interruption⁷¹. The examination should be explained in detail and verbal and written consent obtained. The low risk of priapism should be clearly stated.⁷ A high-frequency linear transducer is used to perform a B-mode/colour Doppler examination of the penis. There are variable techniques to scanning this region however using a gown or towel to fix the penis with the dorsal aspect accessible can be very useful. The corpus cavernosa, corpus spongiosum and glans are evaluated. The dividing penile septum is a valuable echogenic landmark. Prior to injection, the cavernosal arteries will be seen as fine echogenic parallel lines. Variations in vascular anatomy are common and rarely of clinical significance.

The injection:

- Careful consideration should be given to the dose and recommended injection protocol of the pharmacostimulant. Follow the dosage

recommendations on the product guidelines. A lesser dose can be given to a patient who is highly suspected of having psychogenic impotence as this will decrease the risk of priapism. The higher dose will be more suitable for those who are suspected of having either arterial or venous sources of impotence. Too low a dose however can create a confusing/ non-diagnostic result.

- ii. A single injection into the base of one of the cavernosa is generally sufficient as the agent will disperse into both sides of the penis. A second injection may be considered if there has been an inadequate response to the first injection. Patient anxiety though may reduce the initial response. The risk of priapism should be kept in mind.
- iii. Currently 60mg of papaverine is injected near the penile base.

Post injection:

- i. The response of the agent will be almost immediate. Spectral Doppler waveforms should be performed at 5mins, 10mins, 15mins, 20mins, 25mins, 30min in the proximal 1/3 of each cavernosal artery.
- ii. The peak systolic velocity (PSV) and end-diastolic velocity (EDV) should be recorded using a spectral angle ideally 60°. If 60° is not possible, as near to 60° should be obtained.
- iii. Late erectile responses at 30 to 40minutes have been reported.
- iv. The examination can be curtailed if normal arterial and venous responses are obtained prior to 30mins.
- v. The engorged penis provides another opportunity for B-mode and colour evaluation for plaques, fibrosis and anatomical/structural change. This should be performed across the examination period. The erectile response is graded visually from E0–E5 .grade E4 and E5 are sufficient for penetration.^{7,1}

E0: No response

E1: Elongation of shaft only

E2: Moderate tumescence, no rigidity

E3: Full tumescence, no rigidity, easily bendable

E4: Full erection, partial rigidity

E5: Full rigidity for at least 20 minutes

These are further divided into four groups:

- i. Group IV adequate response=E4andE5
- ii. Group III moderate response=E3
- iii. Group II Mild response=E2
- iv. Group I no response=E0 AND E1

Penile color doppler

Penile Doppler is a non-invasive, radiation-free and relatively cheap means of screening for penile arterial insufficiency in patients with ED. Patients initially presenting with ED are typically offered pharmacological therapy on the basis of a clinical assessment involving history and physical examination, and basic laboratory tests. Radiological vascular testing is of most use in the evaluation of patients failing to respond to first-line therapy, and in the context of research. Other specific clinical problems are well suited to evaluation

with penile Doppler. For example, 'high flow' priapism, due to traumatic cavernosal artery tears, gives characteristic appearances of turbulent flow in the arteriovenous fistula (often with a small pseudoaneurysm), high velocity proximal to the arteriovenous fistula and low flow distally (and in the contralateral artery). Color Doppler sonography can be useful in the evaluation of erectile dysfunction, which can result from psychogenic, endocrinologic, neurologic, pharmacologic, and vasogenic causes.³ It is used to determine the integrity of the vascular mechanism. After an intracavernosal injection of a vasodilatory agent, color Doppler sonography is performed to evaluate cavernosal arteries and dorsal vessels. Color flow imaging allows direct visualization of intrapenile anatomy, vascular variants, and disease. It is also helpful in demonstrating transitions in cavernosal and dorsal blood flow. Color Doppler sonography is combined with spectral interrogation of the cavernosal arteries and dorsal veins to help determine peak systolic and end-diastolic velocities. Cavernosal artery size and systolic velocities help diagnose arterial insufficiency. Recent work on cavernosal artery diastolic flow and dorsal vein flow has indicated that color Doppler sonography, when correlated with cavernosographic findings, may be helpful in diagnosing venous incompetence. Temporal variations in transitions in cavernosal artery and dorsal vein flow during various stages of erection are important in the accurate diagnosis of vasogenic impotence.

Interpretation of penile color doppler

We initially scan the flaccid penis to determine the presence of the structural anomalies and plaques. Cavernosal artery diameters can be obtained and are used by some authors in determining arterial integrity. We currently inject 60mg of papaverine intracavernosal near the penile base. Pharmacologic agent used at other institutions to induce erection includes papaverine, phentolamine, prostaglandin E and various combinations. We begin scanning dorsally but ventral transducer placement may be necessary as erection progresses. We alternate scanning of each corpus cavernosum and the dorsum immediately after the injection and at 5minute interval for 20-30minutes.

Temporal response to papaverine

As previously mentioned, we routinely sample both cavernosal arteries at 5minute interval from 1 to 25minutes after papaverine injection or until waveform progression ceases.

Arterial insufficiency

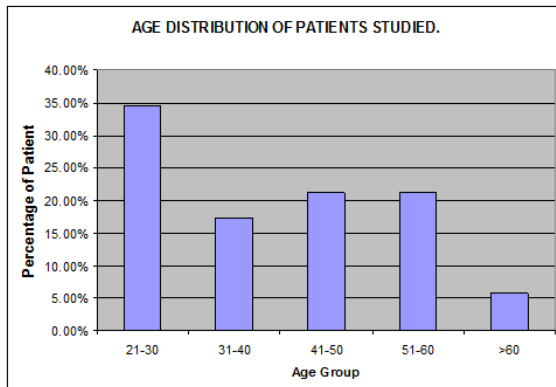
Primary diagnostic criteria for arterial insufficiency include a peak systolic velocity of less than 25cm/sec and waveform dampening. Secondary diagnostic criteria include failure of cavernosal artery dilatation and asymmetry of cavernosal flow velocities of greater than 10cm/sec.^{4,5}

Venous insufficiency: Venous incompetence or veno-occlusive failure may represent the most common cause of vasogenic impotence.⁶ The principal investigators used in arterial end-diastolic velocity of greater than 5cm/sec to diagnose venous leakage. With increasing intracavernosal pressures, there are specific transitions in spectral waveforms, principally a progressive loss of diastolic flow and ultimately diastolic flow reversal. Therefore, the presence of persistent diastolic flow and elevated end-diastolic velocities are indirect indicators of veno-occlusive failure. It should be emphasized that the diagnosis of venous incompetence is made only if the patient has normal peak systolic velocity (25cm/sec). When end-diastolic velocity is used to diagnose venous incompetence, it should require accurate

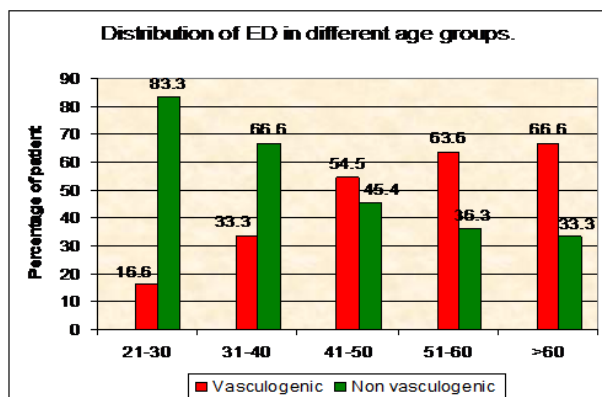
angle correction. Although transient dorsal vein flow is a normal occurrence, persistent dorsal vein flow may reflect veno-occlusive failure.⁷⁻¹⁰

Observations and results

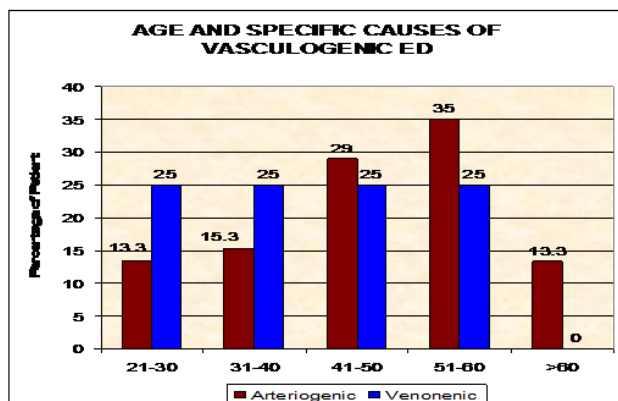
The age distribution of the patients studied was from 21 to 66 years. The maximum number of patients (34.6%) was in the age group 21-30 years (Graphs 1-7).



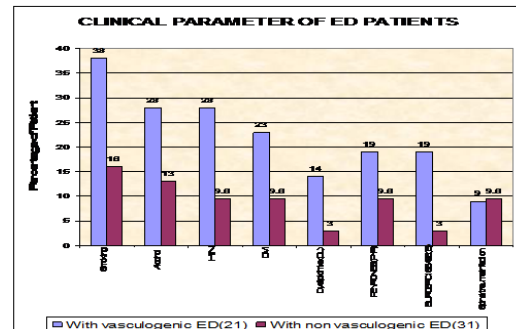
Graph 1 The vasculogenic cause of ED increases with age, percentage distribution in different age group patient was 21-30(16.6%), 31-40(33.3%), 41-50(54.5%), 51-60(63.6%) and >60years (6.6%).



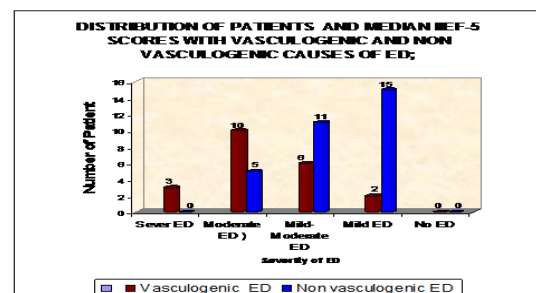
Graph 2 With increase in age there is increase in arteriogenic cause of ED and venogenic causes of ED are approximately same in different age groups.



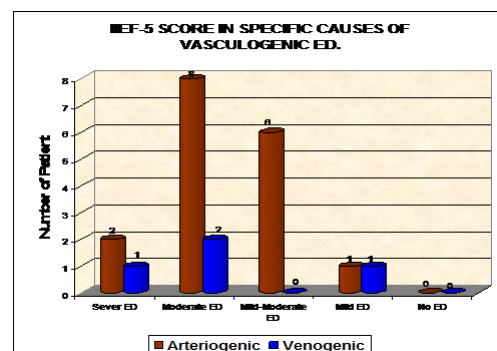
Graph 3 Multiple risk factors were found in majority of the patients with vasculogenic causes of ED.



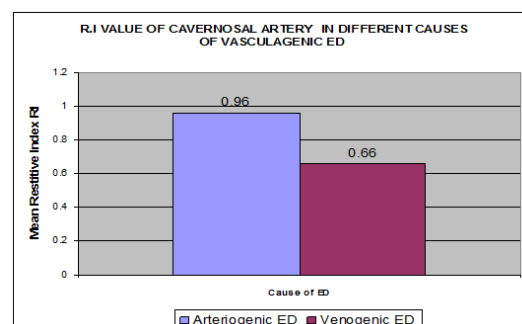
Graph 4 Significant difference was detected in IIEF-5 scores of men with non vasculogenic ED then those with vasculogenic causes of ED.



Graph 5 Median IIEF-5 score was almost same in arteriogenic and venogenic causes of ED and the difference was not significant statistically.



Graph 6 The correlation between the penile rigidity state and its hemodynamic parameters was analyzed. The mean PSV and RI in group I and II were below the normal cut off for vasculogenic ED.



Graph 7 Mean R.I. is found to be helpful in differentiating specific cause of vasculogenic ED. Patients with venogenic ED had significantly lower p-value (0.002) mean R.I.(0.66) compared to mean R.I.(0.96) in arteriogenic ED.

Discussion

The age distribution of the patients studied was from 21 to 66 years maximum number of patient 18(34.6%) were in age group (21-30) years Table 1 (Graph 1). Penile color Doppler examination of 21(40%) patients showed abnormal color Doppler findings were labeled vasculogenic ED patients and 31(60%) patients revealed normal penile vascular system in patients with ED by history were labeled non vasculogenic ED patients. The vasculogenic cause of ED increases with age, percentage distribution in different age group patient was 21-30(16.6%), 31-40(33.3%), 41-50(54.5%), 51-60(63.6%) and >60 years (66.6%) Table 2 (Graph 2). With increase in age there is increase in arteriogenic cause of ED and venogenic causes of ED are approximately same in different age groups Table 3 & (Graph 3). Forty four (84.6%) patients out of a total of 52 patients were married and 9(15.4%) were unmarried. In our study 13(25%) patients were smoker, among smokers 8(61%) patients had vasculogenic ED, compare to 5(38%) patients with non vasculogenic ED Table 4 & (Graph 4). Furthermore, our study highlights the potential interaction of buerger's disease with ED.¹¹⁻¹⁵ Buerger disease was present in 5(9.6% patients) all of them were smokers and 4 out of 5(80%) were suffering from vasculogenic ED. Total 10(19.2%) patient in our study had history of alcohol intake, out of which 6(60%) were vasculogenic ED patients and 4(40%) were non vasculogenic ED patients. In our study 9(17.3%) patients had Hypertension, and among these 6(66.6%) patients had vasculogenic ED thus Hypertension is important risk factor for vasculogenic ED. Out of total 8(15.3%) ED patients with diabetes, 5(62.5%) patients had vasculogenic ED and all of them were arteriogenic ED, thus supporting that diabetes is important risk factor of arterial involvement in patients with ED. Peyronies disease with Calcification/fibrosis of tunica albuginea on grey scale ultrasonography was found in 7(13.4%) of the patients with ED out of which 3(43%) were of vasculogenic ED patients, two third patients were of venogenic ED and one third were arteriogenic ED. In our study a significant difference p-value (0.0006) was detected in IIEF-5 scores of men with non vasculogenic ED then those with vasculogenic causes of ED 15.4 verses 11.3 Table 5 & (Graph 5). However medial IIEF-5 score was almost same in arteriogenic, venogenic causes p-value (0.38) of ED Table 6 & (Graph 6). In our study, the erectile response is graded visually from E0–E5 after

injection of intracavernosal papaverine .grade E4 and E5 are sufficient for penetration. We divide the patients in 4 groups table 7. We compare mean PSV in each group. Mean PSV in Gr-I, II, III and IV is 24.3, 22, 35.9 and 68 respectively PSV in Gr I and II is significantly lower p-value (0.002) then Gr III and IV.¹⁵⁻²⁰

Table 1 Age distribution of patients studied

Age in years	No of patients	Percentage
21-30	18	34.60%
31-40	9	17.30%
41-50	11	21.10%
51-60	11	21.10%
>60	3	5.70%

Table 2 Distribution of ED in different age groups

Causes of ED	21-30 In years (%)	31-40	41-50	51-60	>60	Total
Vasculogenic	3(16.6)	3(33.3)	6(54.5)	7(63.6)	2(66.6)	21
Non vasculogenic	15(83.3)	6(66.6)	5(45.4)	4(36.3)	1(33.3)	31
Total	18	9	11	11	3	52

Chi-square: 8.64, DF: 4, p-value: 0.070789

Table 3 Age and specific causes of vasculogenic ED

Vascular Cause N(%)	21-30	31-40	41-50	51-60	>60	Total
Arteriogenic	2(13.3)	2(15.3)	5(29)	6(35)	2(13.3)	17
Venogenic	1(25)	1(25)	1(25)	1(25)	0	4
Total	3	3	6	7	2	

Chi-squar: 1.39, DF: 4, p-value : 0.8

Table 4 Clinical parameter of Ed patients

Factors	With vasculogenic ED N (%)	With non vasculogenic ED N (%)	P value
Smoking	8(38)	5(16)	0.42
Alcohol	6(28)	4(13)	0.51
HTN	6(28)	3(9.6)	0.58
DM	5(23)	3(9.6)	0.61
Dyslipidimia (DL)	3(14)	1(3)	0.65
Peyronies (PYR)	4(19)	3(9.6)	0.59
Burgers disease(B)	4(19)	1(3)	0.63
Spinal trauma/infection	2(9)	3(9.6)	0.7

Table 5 Distribution of patients and median iief-5scores with vasculogenic and non vasculogenic causes of ED

Specific causes	Sever ED (1-7)	Moderate ED (8-11)	Mild-moderate ED (12-16)	Mild ED (17-21)	No ED (22-25)
Vasculogenic ED	3	10	6	2	0
Non vasculogenic ED	0	5	11	15	0
Total	3	15	17	17	0

Chi sq 17.27, Df 3, P=0.0006

Table 6 IIEF-5 score in SPECIFIC causes of vasculogenic ED

Specific causes	Sever ED (1-7)	Moderate ED (8-11)	Mild-moderate ED (12-16)	Mild ED (17-21)	No ED (22-25)	Median IIEF-5
Arteriogenic	2	8	6	1	0	11.3
Venogenic	1	2	0	1	0	11.2

Chi sq 3.05, Df 3, P=0.38

Table 7 Penile rigidity state and its hemodynamic parameters

Mean PSV(cm/sec)	Gr-IV (E4,E5)	Gr-III (E3)	Gr-II (E2)	Gr-I (E0,E1)
	68	35.93	22	24.3
Avg RI	0.99	0.92	0.88	0.83
Arteriogenic Ed	0	7	8	2
Venogenic ED	0	3	0	1

Chi sq 25.3 , Df 9 , P=0.002

Table 8 R.I Value of cavernosal artery in different causes of vasculogenic ED

Cases (n=21)	Mean resistive index R.I	Standard deviation
Arteriogenic ED	0.96	0.09
Venogenic ED	0.66	0.1

Summary

The present study was carried out on 52 patients in Department of Radio diagnosis G.R. Medical college Gwalior To assess the role of Penile Color Doppler Sonography in the evaluation of erectile dysfunction. In our study 52 (sample size) patients of erectile dysfunction on the basis of IIEF-5 score were subjected to penile color Doppler and differentiated into vasculogenic and non vasculogenic causes of ED. The age distribution of the patients studied was from 21 to 66 years maximum number of patient 18 (34.6%) were in age group (21-30) years. On penile color Doppler examination of 21 (40%) patients showed abnormal color Doppler findings were vasculogenic ED patients and 31 (60%) patients revealed normal penile vascular system in patients with ED by history were non vasculogenic ED patients. The vasculogenic cause of ED increases with age. In our study, we used the PSV as the reference standard to diagnose arteriogenic impotence out of 21 patients of vasculogenic ED on penile color Doppler, 17 (81%) patients with low PSV values (<25 cm/s) in the cavernosal artery were considered to have arterial insufficiency and 4 (19%) patients with adequate arterial inflow that is, normal PSV, a short duration erection, with the persistent antegrade flow of >5 cm/s throughout all phases suggestive of venous incompetence (Venogenic ED). Most

common risk factors found were smoking, followed by hypertension, diabetes, alcohol, Peyronies disease and Bursers disease. In our study a significant difference p-value (0.0006) was detected in IIEF-5 scores of men with non vasculogenic ED then those with vasculogenic causes of ED. The IIEF-5 scores of men with nonvasculogenic causes ED are higher than those with vasculogenic ED causes. However median IIEF-5 score was almost same p-value (0.38) in arteriogenic, venogenic causes of ED. In our study, the erectile response is graded visually from E0-E5 after injection of intracavernosal papaverine. We further divide the patients in 4 groups Gr-I to Gr-IV. Group I and II either had no or minimal response to papaverine which is not sufficient for penetration, group III showed moderate and Group IV showed adequate response to papaverine. We compared mean PSV and R.I in each group, none of the patient in group IV, 55% of the patients in group III and all the patients in group I and II were found to have vasculogenic cause of ED on Penile Color Doppler. Patients in group IV had penile erection which is theoretically taken sufficient to result in penetration had mean PSV and RI 68 and 0.99. Mean PSV and RI in group III was 35.9 and 0.92, PSV and R.I in groups I and II was 24.3, 0.83 and 22, 0.88 respectively. The mean PSV and R.I in group I and II were significantly p-value (0.002) below the normal cut off for vasculogenic ED. EDV>5 is associated with venogenic

ED but can be found in patients with arteriogenic ED since arterial flow is insufficient to cause enough engorgement of sinusoids that can obstruct the venous outflow. Therefore, such threshold values for EDV can be misleading if arterial insufficiency is present. In our study Average R.I is found to be a significant indicator of differentiating vasculogenic ED avg. R.I (0.88) and non vasculogenic ED avg. R.I (0.98).avg. R.I is found to be helpful in differentiating specific cause of vasculogenic ED ,with venogenic ED patients had significantly lower avg.R.I (0.66) compared to arteriogenic ED avg. R.I (0.96) p-value(0.002). Thus the present study provides information as to confirm that an endothelial dysfunction can manifest itself as ED, namely (Arteriogenic or Venogenic) based upon the data provided by PSV and RI levels measurements.²⁰⁻²³

Conclusion

Evaluation of patients based on the International Index of Erectile Function (IIEF-5) is a useful tool to screen a patient with erectile Dysfunction for the etiology and level of dysfunction. However, it is also limited in its usefulness because of the inaccurate and reserved history provided by the patients. A positive response to the pharmacoerection test in terms of rigidity and duration implies normal veno occlusive mechanisms. A duplex ultrasound of the penile arteries should be performed to provide a better selection of therapeutic options.

Limitation

Limitations of penile Doppler include diagnostic misinterpretation as a consequence of the high prevalence of arterial anatomical variants in the penile circulation. For example, distal perforator branches may lead to the spuriously low flow recorded in the proximal cavernosal artery at the base of the penis.

Acknowledgements

None.

Conflict of interest

The author declares no conflict of interest.

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