IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 21, Issue 3 Ser.2 (March. 2022), PP 58-64
www.iosrjournals.org

"Evaluation of Erectile Dysfunction with Pharmaco-Penile Color Doppler Ultrasonography"

VIPIN KUMAR BAKSHI[1]
DEPARTMENT OF RADIO-DIAGNOSIS, DR. S. S. TANTIA M.C.H & R.C., SRI GANGANAGAR, RAJASTHAN (INDIA)

ABSTRACT
INTRODUCTION: *Pharmaco-Penile Colour Doppler Ultrasonography is an important diagnostic tool for evaluation of the vascular mechanism of erectile dysfunction (ED). It can be used to determine the integrity of the vascular mechanism and to differentiate between arterial and venous insufficiency.*
MATERIALS AND METHODS: *A prospective analytical observational study was conducted in the Department of Radio-Diagnosis and Imaging, Jan Sewa Hospital, Sri Ganganagar. A total of 50 consecutive patients in the age range of 24-70 years presenting with symptoms of ED and undergoing Penile Colour Doppler Ultrasonographic evaluation with the intra-cavernosal injection of 2 ml of papaverine were included in this study.*
RESULTS: *The pre-injection baseline diameter of the vessels was <1 mm in 44% of the patients while the majority of the patients (56%) showed a baseline diameter of 1-1.5 mm. Post papaverine injection, the peak increase in the diameter of the vessels in 48% of the patients was <1.5 mm. However, 52% of the patients showed an increase between 1.5 and 2.5 mm. The average peak diameter was 1.77 mm and the P < 0.001, which was significant. 52% of the total patients with low peak systolic velocity (PSV) values (<25 cm/s) in the cavernosal artery were considered to have arterial insufficiency. 8% of the patients with end-diastolic velocity of >5 cm/s had venous insufficiency but normal arterial function, i.e, normal PSV. Adequate arterial inflow, a short duration erection, with the persistent antegrade flow of >5 cm/s throughout all phases was suggestive of venous leak. 40% of the patients studied where found to be functional / psychogenic where no cause could be ascertained.*
CONCLUSION: *Color Doppler evaluation of erectile dysfunction is an effective first line diagnostic method for differentiating psychogenic and vasculogenic causes of erectile dysfunction*

Date of Submission: 25-02-2022 Date of Acceptance: 06-03-2022

I. INTRODUCTION

Erectile dysfunction (ED) is a common health problem which affects men of various age groups; both young and middle-aged men. Pharmaco-penile color duplex Doppler is an important diagnostic tool of evaluation of the vascular mechanism of ED which can result from psychogenic, endocrinologic, neurogenic, pharmacologic, and vasogenic causes. Color duplex Doppler can be used to determine the integrity of the vascular mechanism and to differentiate between arterial and venous insufficiency.

Penile erection is a complex cascade of events, which includes coordinated interaction of the arterial, venous sinusoidal and nervous systems. The penile erectile tissue, specifically the cavernous smooth musculature and the smooth muscles of the arteriolar and arterial walls, plays a key role in the erectile process.[1] A defect or incoordination in any of these systems may result in ED. ED is defined as the consistent inability to generate or maintain an erection of sufficient rigidity for sexual intercourse. Around 10% of men aged 40-70 years have complete, 17.1% have mild, and 25.2% have moderate amount of ED.[2]

ED is closely linked to the general state of both physical and psychological wellness. Among the major risk factors are heart disease, arterial hypertension, diabetes, hyperlipidemia, as well as sedentary lifestyle, smoking and alcohol abuse.[3] Sexual dysfunction is common in patients with alcohol dependence. Heavy drinking proportionately increases the risk.[4]

The normal cascade of events leading to penile erection begins with psychological factors that lead to transmission of parasympathetic impulses to the penis. The walls of the sinusoids and arterioles of the corpora cavernosa relax, which leads to an increased inflow of blood via the cavernosal artery. With filling of the sinusoidal spaces, corporal veno-occlusive mechanism works. The emissary veins exiting the corpora are passively compressed against the fibrous tunica albuginea following which rigid penile erection is achieved and maintained. Detumescence occurs due to contraction of trabecular smooth muscle in the corpora cavernosa after neurological stimulation.[2,3]

ED is caused by the interruption in the chain of events including psychogenic, neurogenic, arteriogenic, and venogenic causes. Often more than one cause is combined. Establishing a specific cause is important particularly in young men because of the frequency of correctable vascular abnormalities. Pure arteriogenic impotence accounts for about 30% of cases, and isolated venogenic impotence is found in about 15%. Often ED is caused by a combination of arteriogenic and venogenic causes. Occasionally, organic impotence is caused by morphological abnormalities of the penis such as peyronies disease (PD).[5] Organic etiologies include vascular, neurogenic, PD, medication side effects and endocrinologic sources. Vascular causes are commonly due to focal arterial occlusive disease.[6]

The cavernosal arteries are the primary source of blood flow to the corpora cavernosa; the dorsal arteries supply blood to the skin and glans of the penis. The cavernosal arteries are connected by multiple anastomotic channels to the dorsal arteries. Arteriography with selective internal iliac angiography is considered the gold standard in the evaluation of arteriogenic impotence. However, this technique is invasive and therefore not suitable as a screening examination.[5] The use of Doppler ultrasound in the assessment of the penile vasculature was first described in 1985.[7]

Penile color Doppler sonography is a valuable method for evaluating ED and it has become the first line diagnostic tool in diagnosing vasculogenic impotence.[8] This method requires intracorporeal injection of a vasoactive substance such as papaverine hydrochloride or prostaglandin E1, however, there are some concerns about the safety of this method due to the intracorporeal pharmacological injection, which may cause priapism as a complication, histological changes and functional impairment resulting in penile fibrosis.[9]

In 1982 during a vascular reconstructive procedure, Ronald Virag noted that an infusion of papaverine into the hypogastric artery produced an erection. In 1983, a dramatic demonstration of the efficacy of penile self- injection was offered by Brindley, who injected himself.[10,11] Virag et al. showed that precise Doppler sampling and blood velocity measurements of the deep cavernosal arteries could be performed before and after intracavernosal injection of vasodilating agents and 75% increase in vessel diameter is good indication of normal arterial flow into the cavernosal artery.[5,12]

Commonly many investigators use 2 ml solution of 60 mg of papavarine into either the right or left corpus cavernosum.[13,14] The investigators concluded that a peak systolic velocity (PSV) of >25 cm/s was normal.[5,15,16] The parameters that indicate the presence of arterial disease are a subnormal response to vasoactive agents, a diameter of <60% increase in the cavernosal artery, and a PSV of the cavernosal arteries <25 cm/s. In the presence of normal arterial function, Doppler findings suggestive of an abnormal venous leak are persistent end-diastolic velocity (EDV) of the cavernosal artery >5 cm/s and demonstration of flow in the deep dorsal vein. The development of Diastolic flow reversal after an injection has been found to be a reliable indicator of venous competence.[5]

II. MATERIALS AND METHODS

A prospective analytical observational study was conducted in the Department of Radio-Diagnosis and Imaging, Jan Sewa Hospital, Sri Ganganagar. A total of 50 consecutive patients in the age range of 24-70 years presenting with symptoms of ED and undergoing Penile Colour Doppler Ultrasonographic evaluation with the intra-cavernosal injection of 2 ml of papaverine were included in this study.

Exclusion Criteria

Patients with heart diseases, known cases of PD and patients with known history of drug allergy were excluded from the study.

Primarily, a gray scale ultrasound was performed in transverse and the longitudinal sections to see any plaque or any other abnormality. A brief history of the patient was taken with adequate privacy and in a quiet environment to alleviate patient anxiety as much as possible. The study was performed on ultrasound machine with broadband linear array high-frequency transducer. Doppler was performed with the patient supine and the penis in the anatomical position, lying on the anterior abdominal wall. Factors such as accurate gate placement, sampling and angle correction were optimized for consistent and reproducible results. Cavernosal artery spectral waveform was measured at the base of the penis as angle correction is optimal, and the velocities are highest here.

Intracavernosal injection of 2 ml of papaverine with a 28 G needle under ultrasound guidance and aseptic precautions close to the base of the penis was done and massaged in. The peak systolic and EDV measurements were obtained in the right cavernosal artery at 5 min intervals for a total of 30 min. The systolic velocity of <25 cm/s was used as the threshold for arterial insufficiency. An EDV of >5 cm/s was used to predict venous incompetence. Erection was graded at a 10 min scale as follows: 1 - no erection; 2 - slight tumescence; 3 - full volume without rigidity; 4 - incomplete rigidity but sufficient for sexual intercourse; and 5 - full erection with unbending rigidity.[10,17]

III. RESULTS AND DISCUSSION

A prospective analytical observational study was conducted in the Department of Radio-Diagnosis and Imaging, Jan Sewa Hospital, Sri Ganganagar. A total of 50 consecutive patients in the age range of 24-70 years presenting with symptoms of ED and undergoing Penile Colour Doppler Ultrasonographic evaluation with the intra-cavernosal injection of 2 ml of papaverine were included in this study. The results were tabulated & categorically arranged and statistical analysis was carried out.

In our study, majority of the patients studied were in the 3rd decade. Age distribution of patients studied showed 50% patients in the age range 31-40 years, followed by 25% in the age range of 21-30 years..35 (70%) patients out of a total of 50 patients were married.

Personal habits of the patients studied showed a significant (75%) of the patients were smokers, a study by Austoni et al. showed a dose-and-duration-response relationship between smoking and erectile dysfunction.[18] Another population-based cross-sectional study of 1580 participants study by Chew et al. compared non-smokers, former smokers and smoker and found smokers to have significantly higher odds of ED.[19] A study by Wu et al. of 2686 Chinese men revealed smokers who smoked ≥20 cigarettes daily had a significantly increased risk of ED than never smokers the study also revealed heavy smoking might cause ED and that the duration of the habit increases the risk of ED.[20] Furthermore, our study highlights the potential interaction of smoking with ED. A significant 65% of patients were found to have a history of alcohol intake. A study by Dachille et al. demonstrated a significant relationship between alcohol consumption and ED. 25% of the patients had history of consumption of pan masala, a recent animal experimental study by Nigam and Venkatakrishna-Bhatt on the effect of blended tobacco products on the reproductive system of mice showed significant adverse effects on the reproductive system.[21]

Only 5 (10%) patients had a history of hypertension, none of the patients studied had a history of diabetes mellitus. In the second Princeton consensus, Jackson et al. concluded that a man with ED and no cardiac symptoms is a patient with cardiac (or vascular) disease until proven otherwise.[22]

The base-line diameter of the vessels at 0 min post- injection was <1 mm in 44% of the patients studied, the majority of the patients 56% showed a baseline diameter of 1-1.5 mm. Post papaverine injection, the peak increase in the diameter of the vessels in 48% of the patients was <1.5 mm. However, 52% of the patients showed an increase between 1.5 and 2.5 mm. The average peak diameter was 1.77 mm and the $P <$ 0.001, which was significant. A study by Acharya and Vasu showed the post-injection mean diameter was 1.0 mm,[23] however, our study found a mean increase of 1.7 mm.

In our study, the PSV was graded as Grade I: <25 cm/s, Grade II: 25-30 cm/s, and Grade III: >30 cm/s. The EDV was graded as <5.0 cm/s and above >5.0 cm/s. In our study, we used the PSV as the reference standard to diagnose arteriogenic impotence. 52% of the total patients with low peak systolic velocity (PSV) values (<25 cm/s) in the cavernosal artery were considered to have arterial insufficiency. 8% of the patients with end-diastolic velocity of >5 cm/s had venous insufficiency but normal arterial function, i.e, normal PSV. Adequate arterial inflow, a short duration erection, with the persistent antegrade flow of >5 cm/s throughout all phases was suggestive of venous leak. 40% of the patients studied where found to be functional / psychogenic where no cause could be ascertained.

PHARMACO-PENILE DOPPLER ULTRASONOGRAPHIC IMAGES

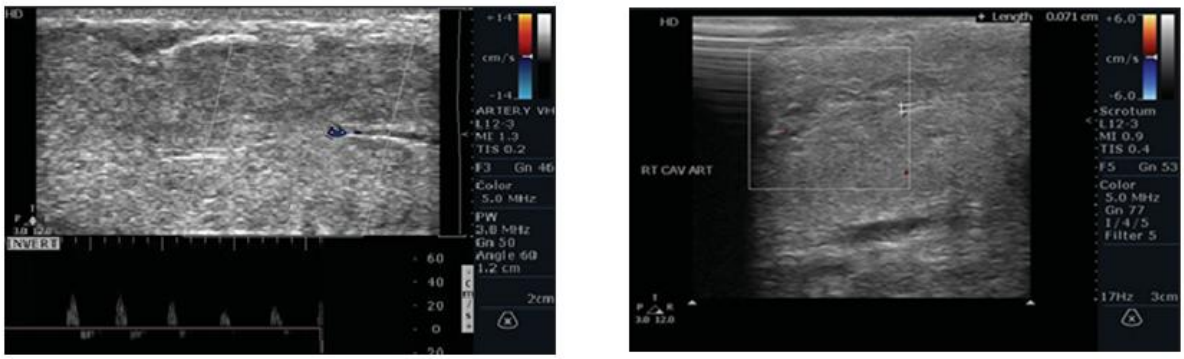


FIGURE 1 SHOWING NORMAL PEAK SYSTOLIC VELOCITY OF >35 CM/S WITH END DIASTOLIC FLOW REVERSAL, SUGGESTING NORMAL STUDY AND FIGURE 2 SHOWING PRE-INJECTION CALIPERS DEPICTING THE BASELINE DIAMETER OF VESSELS

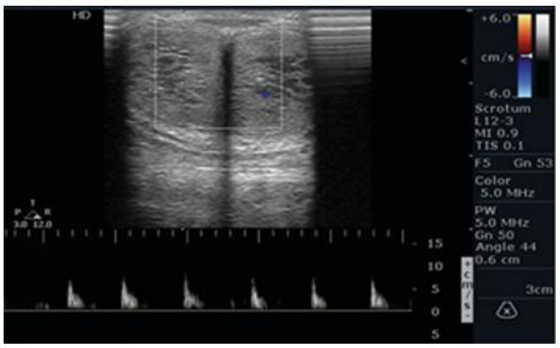
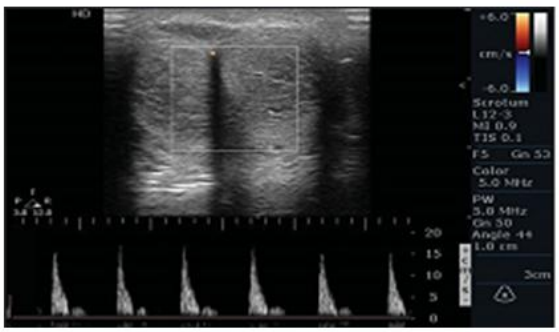


FIGURE 3 SHOWING POST-INTRACAVERNOSAL INJECTION OF PAPAVERINE, CALIPERS REVEALING INCREASE IN DIAMETER OF INTRACAVERNOSAL VESSEL AND FIGURE 4 SHOWING 10 MINS POST-INJECTION SHOWING LOW PEAK SYSTOLIC VELOCITY OF 10 CM/S WITH DIASTOLIC FLOW OF <5 CM/S



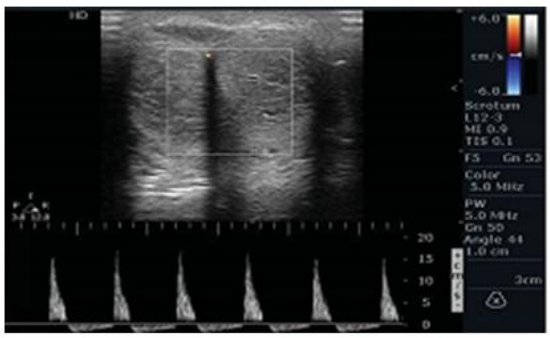
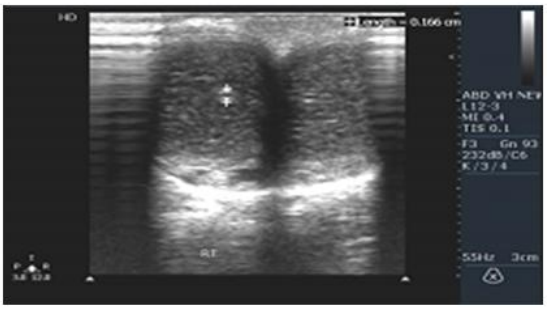


FIGURE 5 SHOWING 15 MINS POST-INJECTION SHOWING LOW PEAK SYSTOLIC VELOCITY OF 15 CM/S AND FIGURE 6 SHOWING 25 MINS POST-INJECTION SHOWING LOW PEAK SYSTOLIC VELOCITY OF 15 CM/S WITH DIASTOLIC FLOW REVERSAL

INTERPRETATION OF FIGURES 3-6: STUDY REVEALED FOLLOWING PAPAVERINE INJECTION NO SIGNIFICANT INCREASE IN THE DIAMETER OF CAVERNOSAL VESSEL AND MAXIMUM PEAK SYSTOLIC VELOCITY REMAINED <15 CM/S WITH DIASTOLIC FLOW REVERSAL, SUGGESTING ARTERIAL INSUFFICIENCY

PHARMACO-PENILE DOPPLER ULTRASONOGRAPHIC IMAGES (CONTINUED)



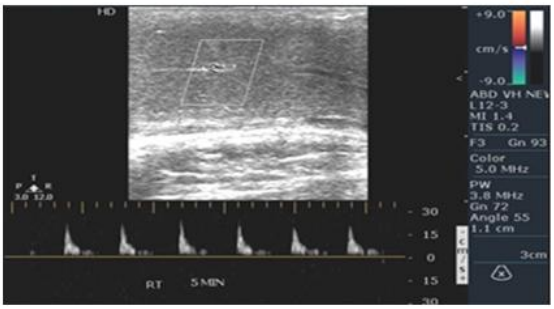


FIGURE 7 SHOWING POST-INJECTION INCREASE IN DIAMETER OF CAVERNOSAL ARTERY AND FIGURE 8 SHOWING STATUS OF CAVERNOSAL ARTERY AND SPECTRAL WAVEFORM 5 MINS POST-INJECTION

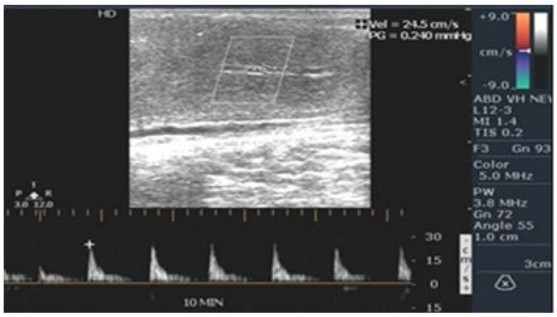
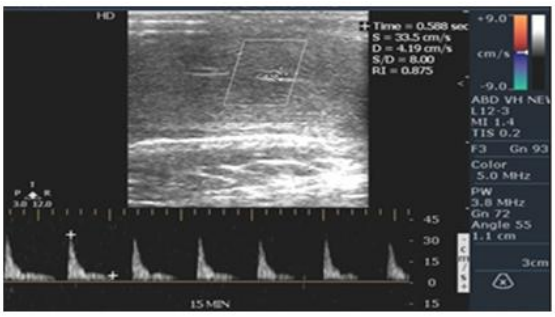



FIGURE 9 AND FIGURE 10 SHOWING STATUS OF CAVERNOSAL ARTERY AND SPECTRAL WAVEFORM 10 & 15 MINS POST-INJECTION, RESPECTIVELY

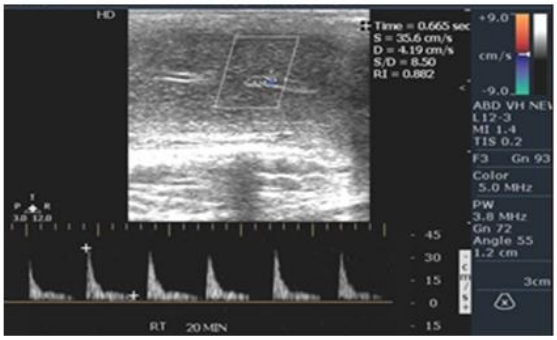
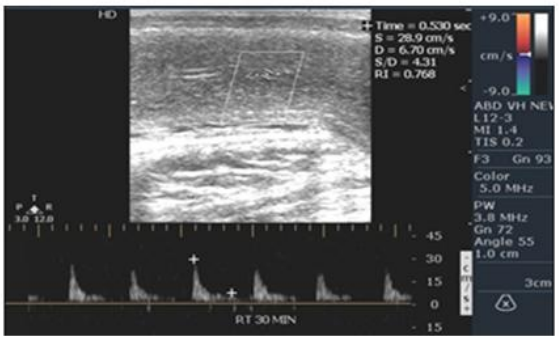
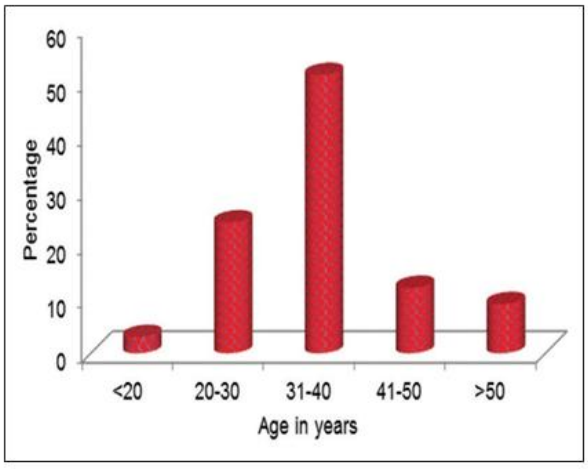
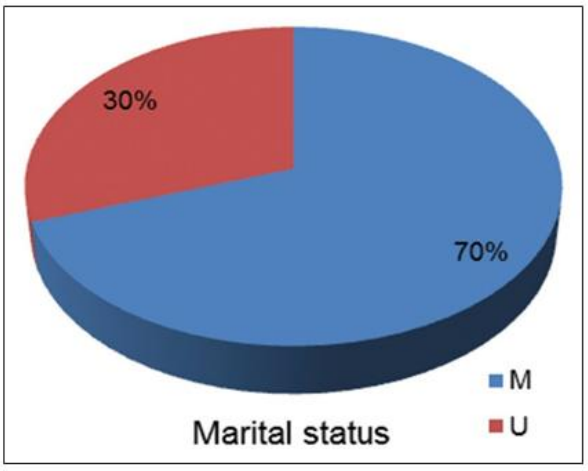



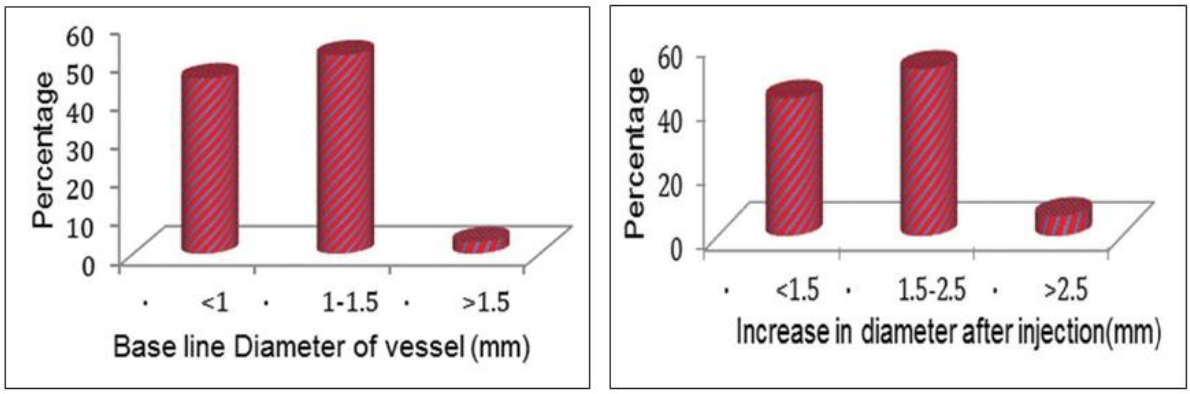
FIGURE 11 AND FIGURE 12 SHOWING STATUS OF CAVERNOSAL ARTERY AND SPECTRAL WAVEFORM 20 & 30 MINS POST-INJECTION, RESPECTIVELY DEPICTING REDUCED PEAK SYSTOLIC VELOCITY WITH CONTINUOUS DIASTOLIC FLOW OF >5 CM/S WITH NO DIASTOLIC REVERSALSUGGESTING VENOUS INSUFFICIENCY.

INTERPRETATION OF FIGURES 7-12: THERE IS NORMAL INCREASE IN THE BASELINE DIAMETER OF THE VESSEL POST-PAPAVERINE INJECTION WITH NORMAL PEAK SYSTOLIC VELOCITIES MORE THAN 35 CM/S WITH CONTINUOUS END DIASTOLIC VELOCITY OF MORE THAN 5 CM/S WITH NO DIASTOLIC REVERSAL. SUGGESTING VENOUS INSUFFICIENCY

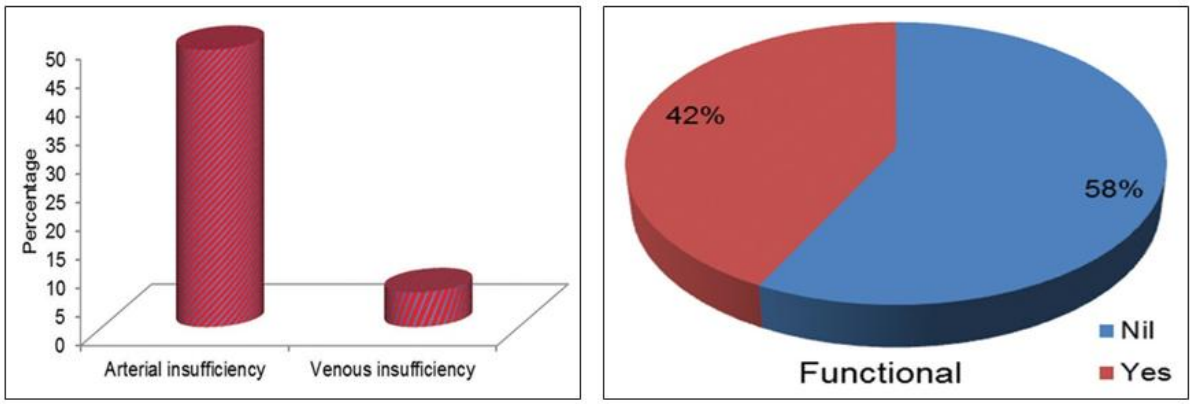




GRAPH SHOWING AGE DISTRIBUTION AND BAR DIAGRAM SHOWING MARITAL STATUS OF PATIENTS WITH ERECTILE DYSFUNCTION STUDIED



GRAPHS SHOWING PRE-INJECTION BASELINE DIAMETER OF CAVERNOSAL ARTERIES STUDIED AND PERCENTAGE INCREASE IN DIAMETER POST-PAPAVERINE INJECTION



GRAPH AND BAR DIAGRAM SHOWING ETIOLOGICAL STRATIFICATION OF PATIENTS WITH ERECTILE DYSFUNCTION STUDIED

Complications

98% of the total patients studied did not show any complications, however, 1 case showed priapism. Our findings are similar to a study by Kilic et al. where complication of priapism were noted in 18 of the 672 patients studied.[13]. The single case of priapism in our study did not show any arterial or venous insufficiency.

IV. CONCLUSION

Color Doppler evaluation of erectile dysfunction is an effective first line diagnostic method for differentiating psychogenic and vasculogenic causes of erectile dysfunction. When arterial insufficiency is found, patients can be considered to have systemic arteriovascular disease. On the other hand, veno-occlusive dysfunction is not correlated with systemic arterial vascular problems. In conclusion, investigating the hemodynamics and direction of flow in the cavernosal artery by color duplex Doppler for ED is primary, time saving & bedside diagnostic maneuever and serves as a guiding light for clinician to develop vascular profiles to help predict treatment success with one or a combination of several agents.

REFERENCES

[1]. Dean RC, Lue TF. Physiology of penile erection and pathophysiology oferectile dysfunction. Urol Clin North Am 2005;32:379-95, v.
[2]. Levine LA. Erectile dysfunction: A review of a common problem in rapidevolution. Prim Care Update Ob Gyns 2000;7:124-129.
[3]. Efremov EA, Kasatonova EV, Mel'nik JI. Use of sildenafil citrate for treatment of erectile dysfunction of various etiology. Urologiia 2015:117-8, 120-1.
[4]. Arackal BS, Benegal V. Prevalence of sexual dysfunction in male subjects with alcohol dependence. Indian J Psychiatry 2007;49:109-12.
[5]. Clifford A, Toppo J. Role of penile color doppler in the evaluation of erectile dysfunction. Indian J Radiol Imaging 2006;16:891-6.
[6]. Ludwig W, Phillips M. Organic causes of erectile dysfunction in men under40. Urol Int 2014;92:1-6.
[7]. Lue TF, Hricak H, Marich KW, Tanagho EA. Vasculogenic impotence evaluated by high-resolution ultrasonography and pulsed Doppler spectrumanalysis. Radiology 1985;155:777-81.
[8]. Meuleman EJ, Diemont WL. Investigation of erectile dysfunction. Diagnostic testing for vascular factors in erectile dysfunction. Urol Clin North Am 1995;22:803-19.
[9]. Shamloul R, Ghanem HM, Salem A, Kamel II, Mousa AA. The value of penile duplex in the prediction of intracavernous drug-induced priapism. IntJ Impot Res 2004;16:78-9.

[10]. Bari V, Ahmed MN, Rafique MZ, Ashraf K, Memon WA, Usman MU. Evaluation of erectile dysfunction with color Doppler sonography. J Pak Med Assoc 2006;56:258-61.
[11]. Glina S, Virag R, Luis Rhoden E, Sharlip ID. Intracavernous injection of papaverine for erectile failure. J Sex Med 2010;7:1331-5.
[12]. Virag R, Frydman D, Legman M, Virag H. Intracavernous injection of papaverine as a diagnostic and therapeutic method in erectile failure. Angiology 1984;35:79-87.
[13]. Kilic M, Serefoglu EC, Ozdemir AT, Balbay MD. The actual incidence of papaverine-induced priapism in patients with erectile dysfunction followingpenile colour Doppler ultrasonography. Andrologia 2010;42:1-4.
[14]. Lue TF, Mueller SC, Jow YR, Hwang TI. Functional evaluation of penile arteries with duplex ultrasound in vasodilator-induced erection. Urol Clin North Am 1989;16:799-807.
[15]. Yavas US, Calisir C, Kaya T, Degirmenci NA. A sign of arteriogenic insufficiency on penile Doppler sonography: Retrograde flow in penile cavernosal-spongiosal communications. J Ultrasound Med 2007;26:1643-8.
[16]. Golijanin D, Singer E, Davis R, Bhatt S, Seftel A, Dogra V. Doppler evaluation of erectile dysfunction - part 1. Int J Impot Res 2007;19:37-42.
[17]. Porst H. Duplex ultrasound of the penis. Value of a new diagnostic procedure based on over 1,000 patients. Urologe A 1993;32:242-9.
[18]. Austoni E, Mirone V, Parazzini F, Fasolo CB, Turchi P, Pescatori ES, *et al.* Smoking as a risk factor for erectile dysfunction: Data from the andrology prevention weeks 2001-2002 a study of the Italian Society of Andrology (S.I.A.). Eur Urol 2005;48:810-7.
[19]. Chew KK, Bremner A, Stuckey B, Earle C, Jamrozik K. Is the relationshipbetween cigarette smoking and male erectile dysfunction independent of cardiovascular disease? Findings from a population-based cross-sectional study. J Sex Med 2009;6:222-31.
[20]. Wu C, Zhang H, Gao Y, Tan A, Yang X, Lu Z, *et al*. The association of smoking and erectile dysfunction: Results from the fangchenggang area male health and examination survey (FAMHES). J Androl 2012;33:59-65.
[21]. Nigam SK, Venkatakrishna-Bhatt H. Analysis and toxicity of plain (PMP) and blended (PMT) Indian pan masala (PM). Eurasian J Med 2013;45:21-33.
[22]. Jackson G, Rosen RC, Kloner RA, Kostis JB. The second Princeton consensus on sexual dysfunction and cardiac risk: New guidelines for sexual medicine. J Sex Med 2006;3:28-36.
[23]. Acharya D, Vasu CK. Penile Doppler evaluation of erectile dysfunct. J EvolMed Dent Sci 2014;3:7102-7.
[24]. Suresh A, Balachandran A, Indira N, Ramprakash HV. Role of Penile Color Doppler in the Evaluation of Erectile Dysfunction. Int J Sci Stud 2015;3(7):23-32.