EVALUATION OF ERECTILE DYSFUNCTION WITH DUPLEX COLOUR DOPPLER SONOGRAPHY OF PATIENTS PRESENTING IN IGIMS, PATNA

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ABSTRACT

BACKGROUND

Duplex colour Doppler sonography is a useful tool for the evaluation of erectile dysfunction, especially for organic causes like arterial and venous. The causes of erectile dysfunction are multiple. It could be vasculogenic, psychogenic, endocrinologic, neurologic and pharmacologic.

Objective- To evaluate the role of duplex colour Doppler sonography for erectile dysfunction.

MATERIALS AND METHODS

An observational cross-sectional study was conducted at the Radiology Department of IGIMS, Patna from 06/04/17 to 30/12/17. All consecutive patients presenting with erectile dysfunction and who were undergoing penile Doppler evaluation with intracavernosal injection of papaverine 60 mg (2 mL) were included in this study.

RESULTS

A total of 21 patients with age range of 20 - 59 years were included in the study. A normal response was noted in 15 patients (psychogenic cases). Vasculogenic causes were observed in six patients, two with arterial insufficiency and four with venous leak. Peyronie's disease was diagnosed in three patients.

CONCLUSION

Penile colour Doppler sonographic evaluation with papaverine is an excellent, effective, accurate and technically easy method of assessing patients with erectile dysfunction. It can easily differentiate a psychogenic cause of erectile dysfunction from vasculogenic cause and in vasculogenic cause it can accurately detect arterial insufficiency and venous incompetence.

KEYWORDS

Duplex Penile Colour Doppler, Erectile Dysfunction, Papaverine, Vasculogenic.

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BACKGROUND

Erectile dysfunction is a common occurrence among men of all age groups, ethnicities and cultural backgrounds, and its incidence is expected to increase significantly along with the increase in various lifestyle diseases. Erectile dysfunction initially called as "Impotence" has been defined as the inability to achieve and maintain penile erection, which leads to unsatisfactory multifaceted process of sexual function.^[1] Its incidence is increasing drastically from about 6% in the age group of 20 - 29 years to 50% - 70% in the age group of 40 - 79 years.^[2] Its incidence has been projected to increase significantly to over 320 million by year 2025.^[3] India has been dubbed as the impotence capital of the world due to the high incidence of lifestyle diseases and probably the largest population of male in the world.

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The causes of erectile dysfunction are multiple like psychogenic, vasculogenic, endocrinologic, neurogenic and pharmacologic. Duplex colour Doppler sonographic study basically looks for the integrity and mechanism of the vascular system of penis.^[4] Thus, it can be useful in the evaluation of erectile dysfunction if it is vascular in origin and easily exclude psychogenic and other medical causes. The objective of this study was to assess the role of duplex colour Doppler sonography in the evaluation of erectile dysfunction.

MATERIALS AND METHODS

An observational cross-sectional study was conducted in the Department of IGIMS, Patna from 6/4/17 to 30/12/17. A total of 21 consecutive patients presenting with erectile dysfunction were included and all underwent penile colour Doppler evaluation with injection of papaverine 2 mL intracavernosal used in this study.

First gray scale ultrasound was done in both longitudinal as well as transverse planes to assess anatomical abnormality or plaque deposition. Further a baseline study of cavernosal arteries and pre-injection velocities of cavernosal arteries were noted. Before doing ultrasound, a brief history of patients was taken and adequate privacy and quiet surrounding were provided to allay their anxiety as much as possible. The study was performed by one of three experienced radiologists. All studies were done on Samsung

H60 high end colour Doppler machine with high frequency transducer having colour and Duplex Doppler facilities. With necessary corrections like accurate gate placement and angle optimisation, spectral waveform from the cavernosal artery were measured and noted down, especially at the base of penis as arterial diameter and velocities are maximum here.

Intracavernosal injection of papaverine 2 mL (60 mg), one mL in each cavernosal muscle was given with insulin syringe at the base of penis and compressed as well as massaged in with fingers. Now measurement of each cavernosal arteries diameter, peak systolic and end-diastolic velocities were taken at every 5 minutes interval for a total of 30 minutes. In this duration, a peak systolic velocity of less than 25 cm/sec was taken as the threshold for arterial insufficiency. An end-diastolic velocity of greater than 5 cm/sec was taken as the threshold to say venous incompetence. The images were recorded and printed in paper. Mostly, a complete erection was noted towards the end of 10 minutes assessment. This erection (at 10 minute) was graded as follows:^[4]

- Grade 1- No Erection,
- Grade 2- Slight Erection/Tumescence,
- Grade 3- Full Volume Erection without Rigidity,
- Grade 4- Full Volume Erection with Incomplete Rigidity, but sufficient to sexual activity.
- Grade 5- Full Erection with Unbending Rigidity.

No abnormal complication regarding intracavernosal injection or papaverine were observed in 3 hours post injection.

RESULTS

21 patients with an age range of 20 - 59 years were included in the study. A vast majority was in the 31 - 50 years' age group (71.42%). Four patients (19.05%) had developed erectile dysfunction before any sexual activity and 17 patients (80.95%) had developed this problem after a normal period of sexual life. The duration of symptoms varied from 1 month to 24 months in acquired cases of erectile dysfunction. Two patients had diabetes mellitus and hypertension, and all of them had arterial insufficiency.

A normal response was noted in 15 patients (71.42%) and their problem was considered as psychogenic. Most of them achieved a peak systolic velocity of greater than or equal to 44 cm/sec and had either reversal of flow in diastole or an end diastolic velocity were less than 5 cm/sec. The largest peak systolic velocity attained was 62 cm/sec. Gradual loss of erection was noted in all cases in about 15 - 30 minutes of injection. No intracavernosal haematoma or any case of priapism was encountered in this study.

Vasculogenic causes were noted in six (28.57%), in which two patients showed arterial insufficiency and four patients showed venous leak. The lowest peak systolic velocity in arterial insufficiency patients was 12 cm/sec and highest velocity achieved was 20 - 21 cm/sec. In patients with venous leak the end-diastolic velocity was above 6 cm/sec and highest velocity was 8 - 10 cm/sec. Patients with vasculogenic causes did not show satisfactory penile erection.

Peyronie's disease was diagnosed in three patients (14.29%) with plaques in tunica albuginea, which were visible in gray scale and palpable on lateral and anterior surface, but no characteristic abnormal curvature of the penis or discomfort during Doppler evaluation noted. These

patients had some delayed response to injection papaverine, but did not reveal arterial or venous insufficiency.

Mean pre-injection inner diameter of cavernosal artery was 0.3 - 0.5 mm and post injection mean inner diameter was 0.6 - 1.2 mm represented the normal compliance of cavernosal arteries in patients with erectile dysfunction as greater than 75% increase in diameter of artery taken as good indication of normal arterial flow and below which abnormal was seen in two (9.52%).

Out of 21 patients, two (9.52%) had complaints of diabetes mellitus and hypertension and are also under medication. All of them had arterial insufficiency, where peak systolic velocity were 12 - 20 cm/sec.

Figure 1. Transverse Scanning Plan of Penis (Pre-Injection) showing both side Corpus cavernosum surrounded by Echogenic Fibrous Capsule Tunica albuginea. Not any Calcified Plaque was seen over Tunica albuginea or within cavernosum. Cavernosal artery barely Seen

Figure 2. Longitudinal Scanning of Penis in Post-Injection Phase showing well-delineated Dilated Cavernosal Artery

Figure 3. Split Images of Transverse Scan of Penis (Colour Doppler) showing Small Calibre both Cavernosal Arteries with Faint Colour Flow in Pre-Injection Phase (Left Side), Post-Injection Phase (Right Side) shows Dilated Cavernosal Arteries with defined Colour Flow (Blue Coding) and also Helicine Artery (Red Coding)

Figure 4. Normal Duplex Colour Doppler of Cavernosal Artery in Pre-Injection Phase showing Monophasic Spectral Pattern of Flow with Velocity around 10 cm/sec

Figure 5. Normal Duplex Colour Doppler of Cavernosal Artery at 5 minutes interval after Intracavernosal Injection of Vasodilator Papaverine showing Increase in both Systolic and Diastolic Flow

Figure 6. Normal Duplex Colour Doppler of Cavernosal Artery at 10 minutes interval after Papaverine Injection showing Shoot of Systolic Flow (55 cm/sec) and declining of Diastolic Flow (2 - 3 cm/sec)

Figure 7. Normal Duplex Sonography of Cavernosal Artery at 15 - 20 minutes interval after Papaverine Injection showing Systolic Flow at maximum (55 - 60 cm/sec) with reversal of Diastolic Flow

Figure 8. Duplex Sonography of Cavernosal Artery Post Papaverine Injection showing no rise of Systolic Flow above the 20 - 21 cm/sec with Normal Diastolic Flow 3 - 4 cm/sec suggesting "Arterial Insufficiency"

Figure 9. Duplex Colour Doppler of Cavernosal Artery after injection of Vasodilator Papaverine showing continuous High Flow in End Diastole 8 - 10 cm/sec with Normal Flow in Systole 38 cm/sec suggesting "Venous Incompetence"

DISCUSSION

The normal male sexual function is multifactorial that occurs in defined sequence: libido, penile erection, ejaculation, orgasm and detumescence. Erectile dysfunction is defined as the consistent inability to achieve and maintain an erection sufficient for satisfactory sexual function resulting from organic disease in up to 80% of cases.^[5]

In 1982 during a vascular reconstructive procedure, Ronald Virag noted that infusion of papaverine into the hypogastric artery produces erection of penis. In 1983, a dramatic demonstration of the efficiency of penile self-injection was offered by Charles Brindley who injected himself.^[6] Lue et al in 1985 introduced the technique of high resolution sonography and quantitative Doppler spectrum analysis.^[7] The demonstration that vasoactive injections could produce penile erection without tactile or psychic stimuli revolutionised the diagnosis and treatment of erectile dysfunction by providing a direct test of end organ integrity and offering an aetiology specific therapy.

Pudendal arteriography is a gold standard technique for penile vascular assessment, but procedure is invasive while Duplex Doppler Sonography is non-invasive and can be easily performed on an outpatient basis. Colour Doppler Sonography allows the direct visualisation of each cavernous artery and Doppler blood flow analysis simultaneously. During penile erection the corporeal vascular bed becomes more compliant and allow gradual increase in arterial inflow, the basic event^[8] leading to increased penile arterial blood volume many times that of flaccid state occurs during the

rapid phase of erection. Duplex Doppler Sonography analysis with intracavernous vasoactive drug injections have established that a peak cavernosal artery systolic flow greater than 25 cm/sec is required for penile erection.^[9] When penile volume increases to maximum, the arterial inflow declines and set to equilibrium state that is sufficient to keep the penis rigid and erected. A peak systolic velocity of 35 cm/sec denotes normal arterial integrity and as velocity getting below of this points towards likelihood of arterial disease. A velocity less than 25 cm/sec indicating a high possibility of severe arterial disease.^[10]

Vasculogenic erectile dysfunction is the most common organic cause^[11] and results from haemodynamic dysfunction with arterial insufficiency in up to 80% cases and remaining due to venous incompetence. Various parameters such as the pre- and post-injection cavernosal artery diameter, peak systolic velocity, degree of cavernosal artery dilatation and acceleration time have been used for the diagnosis of arteriogenic cause while persistent increased end diastolic flow used for venous insufficiency. However, the peak systolic velocity is the most important and accurate parameter of arterial disease.^[6] Penile disease like congenital malformation, Peyronie's disease and phimosis can interfere with erectile dysfunction. Erectile dysfunction secondary to excessive venous leakage is reported with significant increased frequency in clinical studies.^[12] Co-morbidity states especially coronary artery disease increases with erectile dysfunction severity, which may indicate that erectile dysfunction is a prognostic marker of overall health and another important medical condition.

Papaverine is an opium alkaloid and strong direct smooth muscle relaxant causing vasodilatation. Intracavernosal papaverine injection causes direct penile smooth muscle relaxation and consequent filling of corpus cavernosum with blood resulting in erection without tactile or psychic stimuli. Pain at the site of injection is the most common side effect and is dose related. Other side effects associated with injections are local cavernosal haematoma, ecchymosis, prolonged erection (4 - 6 hours), priapism (prolonged erection greater than 6 hours), penile oedema and fibrosis.

Before injection in flaccid state, duplex waveform is monophasic with minimal or no diastolic component. But after papaverine injection there is gradual change in the arterial waveform observed with time and correlated with flaccid and full erect rigid states. In initial stage sudden rise in both systolic and diastolic flow in cavernosal artery is due to fallen vascular resistance. With increase in blood flow and volume in cavernosal leads to increased intracavernosal arterial pressure, increased vascular resistance and decreased end diastolic flow. In full erection phase, systolic wave pattern narrowed and lowered or reversal of diastolic flow seen and finally both systolic and diastolic flow cease to equilibrium. Patient with peak systolic velocity above 25 cm/sec and reversal of diastolic flow in well sustained and full rigid state of penis for at least 20 minutes is considered to have no abnormality and patients with velocity less than 25 cm/sec are considered as arterial insufficiency. In case of venous dysfunction, no decrease or reversal of diastolic flow noted in cavernosal artery with end diastolic flow more than 5 cm/sec.

Greater than 75% increase in cavernosal artery diameter after injection of vasodilating agents, compared with pre-injection diameter is a good indicator of normal flow in cavernosal artery from internal pudendal artery.^[4]

Treatment for arterial insufficiency is primarily surgical correction and about 60% of these patients recover postoperatively. For venous leak, venous ligation or occlusion brings initial recovery of erectile dysfunction reported in 60% - 70% of patients.^[13] However, the long-term benefit rate of penile vein ligation is questionable and only 20% patients have successful life of more than 1 year after surgery. Treatment for structural penile disease depends upon the nature and nature and severity of diseases in case of Peyronie's disease. Medical treatment in early stages and surgical in mature calcified stage.

Erectile dysfunction has important aspect in lawsuits for divorce, rape and damage. Duplex Doppler sonographic evaluation is an important value in such cases. A new non-invasive method for penile Doppler ultrasound evaluation for erectile dysfunction using oral sildenafil and vardenafil as an erection inducing agents have been used and the results of duplex analysis with oral sildenafil were statistically equitable and most convenient compared with intracavernosal injectable agents,^[14] thus can alternatively be used in patients who fear to have injections.^[15]

CONCLUSION

Penile colour Doppler sonographic evaluation with papaverine is an excellent, effective, accurate and technically easy method of assessing patients with erectile dysfunction. It can accurately differentiate a vascular cause of erectile dysfunction from psychogenic and other medical causes of erectile dysfunction. In vasculogenic causes, colour Doppler sonography again can accurately separate arterial insufficiency or venous insufficiency as a cause of erectile dysfunction. As the treatment of erectile dysfunction is now more aetiology specific and thus this method can definitely help clinician to choose the specific therapy.

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