June 2006

Evaluation of erectile dysfunction with color Doppler sonography

Vaqar Bari
Aga Khan University, vaqar.bari@aku.edu

M Nadeem Ahmed
Aga Khan University, nadeem.ahmed@aku.edu

M Zafar Rafique

Kashif Ashraf
Aga Khan University, kashif.ashraf@aku.edu

Waseem Ahmad Memon

See next page for additional authors

Authors
Vaqar Bari, M Nadeem Ahmed, M Zafar Rafique, Kashif Ashraf, Waseem Ahmad Memon, and M Uzair Usman

Original Article

Evaluation of Erectile Dysfunction with Color Doppler Sonography

Vaqar Bari, M. Nadeem Ahmed, M. Zafar Rafique, Kashif Ashraf, Waseem Ahmad Memon, M. Uzair Usman
Radiology Department, Aga Khan University Hospital, Karachi

Abstract

Objective: To assess the role of Color Doppler Sonography in the evaluation of erectile dysfunction.

Methods: A cross-sectional study was conducted at the Radiology Department, Aga Khan University Hospital Karachi from 5-6-2002 to 2-9-2003. All consecutive patients presenting with erectile dysfunction and undergoing penile color Doppler evaluation with injection PGE1 20 mcg were included in this study.

Results: A total of 70 patients with an age range of 24-70 years {mean 41± 12.25 years} were included in the study. A normal response was noted in 45 (psychogenic) cases. Vasculogenic causes were observed in 23 patients, 12 with arterial insufficiency and 11 with venous leak. Peyronie's disease was diagnosed in 2 patients.

Conclusion: Color Doppler evaluation of erectile dysfunction is an effective method for differentiating psychogenic and vasculogenic causes of erectile dysfunction (JPMA 56:258;2006).

Introduction

Color Doppler sonography can be useful in the evaluation of erectile dysfunction, which can result from psychogenic, endocrinologic, neurogenic, pharmacologic, and vasogenic causes. It is used to determine the integrity of the vascular mechanism.

The National Institutes of Health (NIH) Consensus Development Conference[1] advocated that "erectile dysfunction" be used instead of "impotence" to describe disorders of male sexual function and defined the new terminology as the "inability to achieve an erect penis as part of the overall multifaceted process of male sexual function." However, use of the term "erectile dysfunction" to refer to all aspects of male sexual dysfunction would be inappropriate.

Although the exact prevalence of erectile dysfunction in the United States male population is not known, estimates have ranged from 12% of males above age 18 in the report of Furlow[2] to 25-30% of men between ages 60 and 70 in the surveys of Kinsey and colleagues[2], Schiavi and colleagues[3] and Diokno and colleagues[4] and 52% in the Massachusetts Male Aging Study.[5] Disorders of sexual function are common among men of all ages, ethnicities and cultural backgrounds. It has been estimated that more than 152 million men worldwide experienced erectile dysfunction in 1995, and that this number will rise by 170 million, to approximately 322 million by the year 2025.[6]

The objective of this study was to assess the role of color Doppler sonography in the evaluation of erectile dysfunction.

Patients and Methods

The study was conducted at the Radiology Department, Aga Khan University Hospital Karachi from 5-6-2002 to 2-9-2003. A total of 70 consecutive patients presenting with erectile dysfunction and undergoing penile color Doppler evaluation with injection Prostaglandin E_1 20mcg were included in this study.

A grey scale ultrasound was performed in both longitudinal as well as transverse sections to see any plaque or abnormality. This was followed by a baseline study of the cavernosal arteries and pre-injection velocities were recorded. A brief history was taken and adequate privacy and quiet surrounding was provided to allay patient anxiety as much as possible. The study was performed by one of three experienced radiologists. All studies were performed on GE Logiq 500 and Aloka Prosound SSD 4000 Doppler machines with high frequency transducer and duplex and color Doppler facility. Sampling factors, accurate gate placement and angle correction was optimized for consistent and reproducible results. Spectral waveforms from the cavernosal artery were measured at the base of penis as velocities are highest here and angle correction is optimal.

Intracavernosal injection of 20 microgram of prostaglandin E_1 with a 28 G needle close to the base of penis was given and massaged in. Measurements of peak systolic and end-diastolic velocities were obtained in each cavernosal artery at 5-min intervals for a total of 30 minutes. A peak systolic velocity of less than 25 cm/sec was used as the threshold for arterial insufficiency. An end-diastolic velocity of greater than 5 cm/sec was used to predict venous incompetence. The images were recorded and printed on paper. Erection was graded at 10 minutes as follows: 1- no erection; 2- slight tumescence; 3- full volume without rigidity; 4- incomplete rigidity but sufficient for sexual

intercourse; 5- full erection with unbending rigidity.

Results

Seventy patients with an age range of 24-70 years (mean 41 $\pm$ 12.25 years) were included in the study. A vast majority was in the 30-40 years age group (42%). Two patients had primary erectile dysfunction and sixty eight had developed this problem after a period of normal sexual activity. Both patients with primary erectile dysfunction had arterial insufficiency on Doppler study. The duration of symptoms varied from 2 months to 3 years in cases of acquired erectile dysfunction. Four patients had diabetes mellitus and all of them had arterial insufficiency.

A normal response was noted in 45 subjects (64%) and their problem was considered to be psychogenic. Most of them achieved a peak systolic velocity of 50 cms/ sec and had either reversal of flow in diastole or an end diastolic velocity less than 5cms/sec. The highest peak systolic velocity achieved was 105 cms/sec. Detumescence was noted in all these cases in about 20-35 minutes. No priapism case was encountered in this study.

Vasculogenic causes were noted in 23 patients (33%), 12 with arterial insufficiency and 11 with venous leak. The lowest peak systolic velocity in arterial insufficiency patients was 10-13 cms/sec and highest velocity achieved was 22cms/sec. In patients with venous leak, the end diastolic velocity was above 6cms/sec and highest velocity recorded was 16-17 cms/sec. No patient in the vasculogenic group achieved a satisfactory erection.

Peyronie's disease was diagnosed in 2 patients (3%) with plaques in tunica albuginea and one of them had a characteristic development of curvature with discomfort during the Doppler evaluation. The other patient did not develop curvature during the study. These two patients had some delayed response to the injection but did not reveal arterial insufficiency or venous leak.

Discussion

The normal male sexual response cycle can be functionally divided into five interrelated events that occur in a defined sequence: libido, erection, ejaculation, orgasm, and detumescence. The functional classification of the male sexual cycle is the most physically quantifiable one.

In 1982 during a vascular reconstructive procedure, Ronald Virag noted that infusion of papaverine into the hypogastric artery produced erection. In 1983 a dramatic demonstration of the efficacy of penile self injection was offered by Charles Brindley, who injected himself.[7] In 1985 Lue et al introduced the technique of high resolution sonography and quantitative Doppler spectrum analysis.[8] In 1986 Ishii published the first clinical series on prostaglandin E_1 for self injection.[9] Prostaglandin E_1 because of its efficacy and safety (low priapism rates) is the drug of choice for first penile injection. The demonstration that vasoactive injections could produce penile erection without benefit of psychic or tactile stimuli revolutionized the diagnosis and treatment of erectile dysfunction by providing a direct test of end organ integrity and offering an etiology specific therapy.

In contrast to pudendal arteriography, duplex sonography is not invasive and can be performed in the office setting. The high resolution ultrasound probe allows the sonographer to image the individual cavernous arteries selectively and perform Doppler blood flow analysis simultaneously. A fall of resistance within the corporeal vascular bed and the subsequent increase in arterial inflow are the major vascular events leading to erection of the penis.[10] A dramatic increase in penile arterial blood flow to about 25 to 60 times that of the flaccid state occurs during the rapid period of tumescence. Pulse Doppler analysis studies with intracavernous vasoactive drug injections have established that a peak cavernosal artery systolic flow greater than 25 ml/sec is required for erection to occur.[11] At full rigidity, an increase in penile length of 7.5 cm usually requires the entrapment of 80-115 ml of blood. As the penile volume increases to near maximum (from <10 ml in the flaccid state to 60 ml in the erect state), the arterial influx declines and plateaus at a level that is sufficient to keep the penis in the rigid (full erection) state. Dynamic infusion cavernosometry and cavernosography (DICC) studies have shown that a fluid flow rate between 5 and 40 ml/min is required to maintain a normal penis in the erect state.[12] A peak systolic velocity of at least 35 cm/sec indicates normal arterial supply. At peak systolic velocities less than 35 cm/sec, the likelihood and severity of arterial disease increase as the peak systolic velocity decreases, with a peak velocity less than 25 cm/sec indicating a high likelihood of severe arterial disease.[13]

Vascular insufficiency is probably the most common cause of organic male sexual dysfunction.[14] Erectile dysfunction(ED) secondary to excessive venous leakage is being reported with significant frequency in clinical studies.[15] Penile diseases, such as congenital malformation, Peyronie's disease, priapism and phimosis may interfere with erectile function. Vasculogenic ED patients have more markedly impaired endothelial and smooth muscle functions compared with patients having similar risk factors but no ED.[16] The prevalence of co morbidities, such as vascular conditions, increased with ED severity, which may indicate that ED is a prognostic marker of overall health and an important medical condition.[17]

PGE-1 (alprostadil) is a metabolite of arachidonic

acid and is a potent smooth muscle relaxant and vasodilator in man. It also has an α-2 adrenergic blocking effect and hence has the potential of reducing sympathetic overtone in patients with psychogenic erectile dysfunction. The overall erectile response to prostaglandin intracorporeal injections is about 70%.[18] Pain is the most common side effect, occurring in 13-80% of patients and is dose-related. Other side effects associated with PGE-1 injections include local corporeal haematoma or ecchymosis (8%), prolonged erection to between 4 and 6 hours (5%), priapism of greater than 6 h (1%), penile oedema (2%), and fibrosis (2.3%).[19]

About 40% of patients with impotence have evidence of abnormal arterial flow. Generally, these conditions are amenable to surgical correction, and about 60% of these patients recover spontaneous erectile function postoperatively. The NIH Consensus Development Conference on Impotence, held in 1992, recommended that surgical revascularization of the penis be considered experimental and be performed only by expert surgeons and as part of clinical investigation.

Venous ligation results in initial recovery of erectile function within the first 6 months of the surgery as reported in 60% to 70% of patients.[20] However, the long-term success rate of penile vein ligation is poor, with only about 20% of patients able to have normal intercourse more than 1 year after surgery.[21]

Erectile function is an important question in lawsuits for divorce, rape, and damages. Lawyers may abuse the assertion of ED in lawsuits for divorce and rape. Doppler evaluation is of considerable help in such cases. The investigation, interpretation, and characteristics of medicolegal cases may differ in countries with different cultures. The availability of effective and well-tolerated oral medications has dramatically changed the clinical approach to erectile dysfunction. Pharmacotherapy is the preferred cost-effective first-line therapy in the vast majority of patients.[22]

A new noninvasive method for penile Doppler ultrasound (PDU) evaluation of erectile dysfunction using oral sildenafil citrate (Viagra) as an erection induction agent has been used. The results of PDU with oral sildenafil citrate were not statistically different from prostaglandin E_1. Patients commented that although PGE 1 was the strongest erectogenic agent, sildenafil citrate was the most convenient.[23] Vardenafil is another safer alternative compared to more invasive intracavernous injection and is also an alternative for patients who fear injections.[24]

Treatment of structural penile diseases depends upon the nature of the underlying disease. Peyronie's disease can be self-limiting in many cases and may not require therapeutic intervention. Medical treatment is suitable in the acute phase (<12 months) of the disease when the plaque is unstable. Oral therapeutic agents include vitamin E, p-aminobenzoate. Other forms of medical therapy may include local or systemic glucocorticoids and the intralesional injection of a collagenase or a calcium channel blocker (e.g., Verapamil). Medical therapy may help patients with moderate disease, whereas surgical correction is the treatment of choice for those with severe penile deformity.

Color Doppler evaluation of erectile dysfunction is an effective method for differentiating psychogenic and vasculogenic causes of erectile dysfunction. As the choices for therapy increase and become more etiology specific clinicians may look to testing like color Doppler ultrasound to develop vascular profiles to help predict treatment success with one or a combination of several agents.

References

1. National Institutes of Health 1993 NIH Consensus Conference: Impotence. [NIH Consensus Statement 1992;10:1-31] JAMA. 1993:83-90.
2. Kinsey AC, Pomeroy WB, Martin CE. Early sexual growth and activity. In: Sexual Behavior in the Human Male. WB Saunders Co., Philadelphia, PA, 1948, pp. 157-92.
3. Schiavi RC, Schreiner-Engel P, Mandeli J, Schanzer H, Cohen E Healthy aging and male sexual function. Am J Psychiatry 1990;147:766-71.
4. Diokno AC, Brown MB, Herzog AR. Sexual function in the elderly. Arch Intern Med 1990; 150:197-200.
5. Feldman HA, Goldstein I, Hatzichristou DG, Krane RJ, McKinlay JB. Impotence and its medical and psychosocial correlates: results of the Massachusetts Male Aging Study. J Urol 1994;151:54-61.
6. Ayta IA, McKinlay JB, Krane RJ. The likely worldwide increase in erectile dysfunction between 1995 and 2025 and some possible policy consequences. Br J Urol Int 1999;84:50-6.
7. Brindley GS. Cavernosal alpha-blockade: a new technique for investigating and treating erectile impotence. Br J Psych 1983;143:332-37.
8. Lue TF, Hricack H, Marich KW, Tanago EA. Vasculogenic impotence evaluated by high resolution ultrasonography and pulsed Doppler spectrum analysis. Radiology 1985;155:777-81.
9. Ishii N, Watanabe H, Irasawa C. Kikuchi Y, Kobata Y, Kawamura S, et. al. Intracavernous injection of prostaglandin E1 for the treatment of erectile impotence. J Urol 1989;141:323-25.
10. Christ GJ .The penis as a vascular organ. The importance of corporal smooth muscle tone in the control of erection. Urol Clin North Am 1995;22:727- 45.
11. Fitzgerald SW, Erickson SJ, Foley WD, Lipchik EO, Lawson TL. Color Doppler sonography in the evaluation of erectile dysfunction. Radiographics 1992 ;12:3-17.
12. Padma-Nathan H. Dynamic infusion cavernosometry and cavernosography (DICC) and the cavernosal artery systolic occlusion pressure gradient: a complete evaluation of the hemodynamic events of a penile erection. In: Lue TF (ed) World Book of Impotence. Smith-Gordon, London: 1992, pp. 101-3.
13. CB Benson, JE Aruny, MA Vickers Jr. Correlation of duplex sonography with arteriography in patients with erectile dysfunction. Am J Roen 1993;160:71-3.
14. Goldstein I, Siroky MB, Nath RL, McMillian TN, Menzoian JO, Krane RJ Vasculogenic impotence: role of the pelvic steal test. J Urol 1982;128:300-06.
15. Wespes E, Schulman C .Venous impotence: pathophysiology, diagnosis and treatment. J Urol 1993;149:1238-45.
16. Yavuzgil O, Altay B, Zoghi M, Gurgun C, Kayikcioglu M, Kultursay H. Endothelial function in patients with vasculogenic erectile dysfunction. Int J Cardiol 2005;103:19-26.
17. Shabsigh R, Perelman MA, Lockhart DC, Lue TF, Broderick GA . Health issues of men: prevalence and correlates of erectile dysfunction. J Urol 2005;174:662-7.

18. Porst H. The rationale for prostaglandin E1 in erectile failure: a survey of worldwide experience. J Urol 1996;155:802-15.
19. Linet OI, Ogrinc FG. Efficacy and safety of intracavernosal alprostadil in men with erectile dysfunction. The Alprostadil Study Group. N Engl J Med 1996;334:873-7.
20. Sasso F, Gulino G, Weir J, Viggiano AM, Alcini E. Patient selection criteria in the surgical treatment of veno-occlusive dysfunction. J Urol 1999;161:1145-7.
21. Wespes E, Moreira de Goes P, Sattar AA, Schulman C. Objective criteria in the long-term evaluation of penile venous surgery. J Urol 1994;152:888-90.
22. Singh JC, Devasia A, Gnanaraj L, Chacko KN. Erectile dysfunction. Natl Med J India 2005;18:139-43.
23. Bacar MM, Batislam E, Altinok D, Yilmaz E, Bacar H. Sildenafil citrate for penile hemodynamic determination: an alternative to intracavernosal agents in Doppler ultrasound evaluation of erectile dysfunction. Urology 2001;57:623-6.
24. Ardicoglu A, Kocakoc E, Tuygun UO, Bozgeyik Z, Orhan I. Effectiveness of vardenafil versus papaverine in penile Doppler ultrasonography. Urol Int 2005;75:75-9.