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MINIREVIEWS

Erectile dysfunction: Proposed definition and staging for early diagnosis

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Abstract

Erectile dysfunction (ED) is considered a forerunner of cardiovascular disease. Early diagnosis of ED is important for identifying silent cardiovascular illness and reducing morbidity and mortality. ED has to be diagnosed before it interferes with sexual function. Various aspects of ED, methods to assess ED, and different types of ED are briefly discussed in this article. The proposed definition and staging of ED help in early diagnosis and are expected to revolutionize the current concepts of diagnosis and management of ED.

Key Words: Erectile dysfunction; Rigidity of penis; Angle of erection; Vaginal penetration pressure; Post-ejaculatory refractory period; Self-reported erection score; Staging of erectile dysfunction; Transient erectile dysfunction

Core Tip: Early diagnosis of erectile dysfunction (ED) is important to identify and prevent cardiovascular morbidity and mortality. The new proposed definition and staging system serve this purpose. Hope this will revolutionize current concepts in the diagnosis and management of ED.

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INTRODUCTION

Erection is a neurovascular event modulated by psycho-physiological and hormonal factors. Erectile dysfunction (ED) is a common male sexual dysfunction, with a combined prevalence of minimal, moderate, and complete ED is 52 % for men in the age group of 40 to 70 years[1]. Prevalence of ED increases with age. People with diabetes and atherosclerotic vascular disease are more prone to develop ED. ED is an indicator of systemic endothelial dysfunction and a forerunner of coronary artery disease[2,3]. ED leads to changes in sexual behavior and various psychological issues like shame, frustration, anxiety, depression, diminished self-esteem, and relationship issues[4].

The treatment depends upon the cause and severity of ED. Phosphodiesterase type 5 inhibitors (PDE5I) act by inhibiting Phosphodiesterase type 5 (PDE5) enzyme, blocking the breakdown of cyclic guanosine monophosphate (cGMP). This leads to increased levels of cGMP in the corpus cavernosum, which facilitates smooth muscle relaxation and blood flow. Other treatment options include Intraurethral prostaglandin pellets, Intracavernosal injections, and Penile prosthesis, and are used depending upon the clinical scenario. ED and cardiovascular disease (CVD) share many of the same risk factors and experimental results suggest the potential for PDE5 inhibitors in the management of cardiovascular disorders such as myocardial infarction, cardiac hypertrophy, and heart failure[2,3,5-7].

METHODOLOGY

An extensive and thorough search was executed across electronic databases, such as the MEDLINE (PubMed), Scopus, and Google Scholar using the keywords and medical subject headings (MeSH) terms relevant to the "erectile dysfunction, early diagnosis, and cardiovascular disease" and reviewed the diagnostic possibility of early diagnosis of ED. In our clinical practice, we noticed that the majority of people with ED seek medical help in the later stage with established cardiovascular disease. Only very few patients present in the very early stage, where we can effectively treat the condition holistically. We also noticed that our current guidelines are not helping to diagnose ED at a very early stage. Hence, after reviewing the relevant literature and based on our clinical experience, we proposed a definition and staging of ED that helps in early diagnosis.

NORMAL ERECTION

Normal erection and rigidity are important for penetration and successful penetrative sexual intercourse. Penile erection rigidity includes axial rigidity (measured by digital inflexion rigidometer) and radial rigidity (measured by rigi scan) (Figure 1). Axial rigidity is expressed as grams of force required to produce penile buckling and it is found that Rigi scan measured radial rigidity at the base and tip of the penis correlate with axial rigidity[8]. Axial rigidity is the extent to which an object resists deformation in response to an applied force[9]. Axial rigidity of more than 550 g is considered adequate for vaginal penetration[10].

Vaginal penetration pressure (VPP) is the pressure exerted by the walls of the vagina on a penetrating object. It is measured by introducing a truncated probe (of diameter 2.9 centimeters) 5 cm into the vagina (Figure 1). Various factors influence VPP. VPP is 21 millimeters of Hg higher in the superior position compared to the supine position, and VPP decreases by 4 to 58 mm of Hg after sexual (clitoral) stimulation[11].

The angle of erection is another indicator of the level of erection[12-14]. The angle of erection is expressed in different ways in the literature. Some people mention the angle of the penis from the horizontal plane (*e.g.*, 10 degrees above or below the horizontal plane). In contrast, others expressed it in the vertical plane, where zero indicates the penis is pointing upwards touching the abdominal wall, and 180 degrees pointing towards the ground. An unerected (flaccid) penis is directed downwards and during erection, it moves gradually towards the horizontal plane and then moves above the horizontal plane. Ideally, the angle should be measured from the vertical plane. So, we propose a uniform method to measure the angle of erection in a vertical plane with zero pointing to the ground, 90 degrees to the horizontal plane pointing straight forward, and 180 degrees pointing vertically upward, flat against the abdominal wall (Figure 2). The average angle of erection is 105.7 degrees. The angle of erection reduces as the rigidity of the fully erected penis reduces. It usually reduces as the erection becomes weaker. The angle of erection reduces with age. Fully erected penis can be straight or with upward or downward curvature on erection[15]. Sixty-three percent of men have a straight penis, 22.2% have upward curvature and 14.8% have downward curvature. The angle of erection also depends upon other factors like the size of the penis, its attachments to the puboischial rami (the crura) and the anterior surface of the pubic bone (the suspensory and fundiform ligaments), which also need to be considered[16].

The frequency of erection is another parameter that reduces when a person develops ED. But it depends on various factors, including desire. Healthy individuals can have 3 to 5 erections during sleep (commonly during REM sleep), and each erection lasts for 25 to 35 minutes[17]. During the daytime, even without sexual stimulation, spontaneous erection occurs. A total of 10-11 erections occur in 24 hours, which is reduced or absent in people with ED, depending on the severity.

The durability of erection is another important component for successful sexual performance. Decreased durability of erection is another important feature of erectile dysfunction. In people with ED, treatment with PDE5I improves the durability of erection[18].

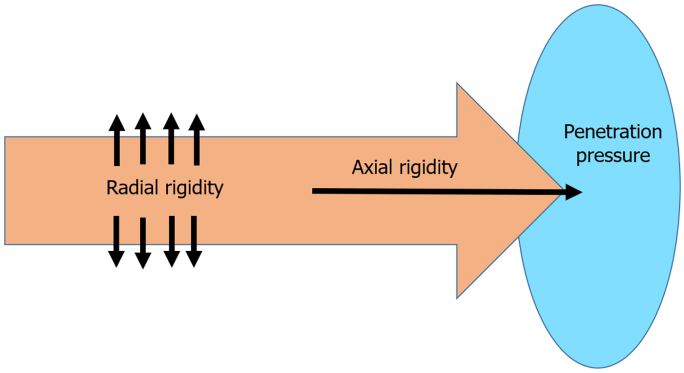

Figure 1 Different forces acting during penetrative sex.

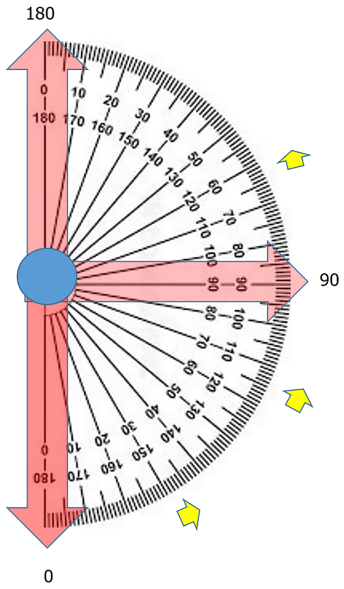

Figure 2 Diagrammatic representation of measurement of the angle of erection.

Post-ejaculatory refractory period (RP) refers to the duration of unresponsiveness of the penis to any erectogenic stimuli after orgasm, ejaculation, and detumescence. The average RP is 30 minutes. The length of the refractory period varies; it can be a few minutes in younger individuals and it can be as long as hours in older men[19,20]. It increases with age and is prolonged in those with ED and improves in those taking PDE5I[21].

ED: CURRENT CONCEPTS

ED, formerly termed impotence, is defined as "the consistent or recurrent inability to achieve and/or maintain an erection sufficient for satisfactory sexual activity. This inability must be persistent at least for six months"[22]. Fourth International Consultation on Sexual Medicine defined ED as the consistent or recurrent inability to attain and/or maintain penile erection sufficient for sexual satisfaction[23].

ED interferes with the sexual pleasure of the person and also of the partner[4]. However sexual performance and sexual satisfaction are impaired only at a later stage of ED. In addition to that, impaired sexual performance, sexual satisfaction, and psychological distress are the consequence of ED, and not a component of ED *per se* (Figure 3). Hence the current definition needs to be updated to include the early stages of erectile dysfunction where sexual performance and sexual satisfaction are not affected. IIEF questionnaire also identifies ED at a later stage. ED is considered a forerunner of future CVD[2]. So early diagnosis of ED is important for early diagnosis of cardiovascular disease and to reduce the risk of morbidity and mortality due to cardiovascular disease effectively. Some consider the penis as a "barometer of overall well-being, not only of cardiovascular health".

Erectile dysfunction is a common male sexual dysfunction characterized by a reduction in the rigidity of the penis assessed objectively or compared to the best and hardest erection the person achieved earlier (acquired). It may or may not interfere with penetrative sex (vaginal, anal, or oral) and sexual satisfaction, depending upon the severity. Erectile dysfunction starts when a person develops a reduction in rigidity. In other words, ED begins when a person feels that his

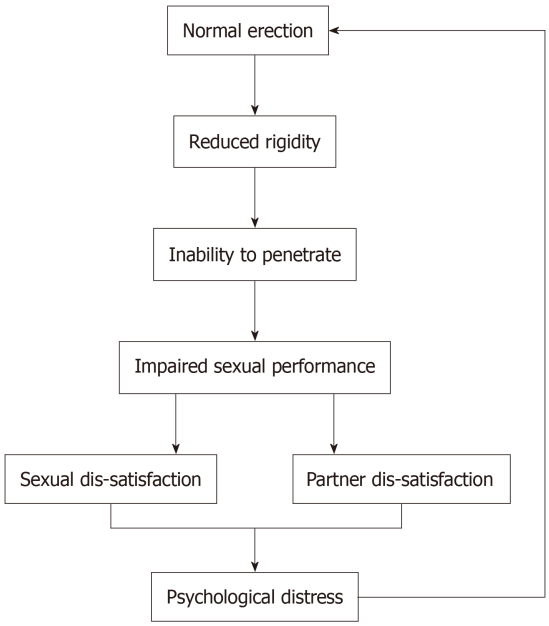

Figure 3 Impaired sexual performance, sexual satisfaction, and psychological distress develop as a consequence of erectile dysfunction, which can subsequently increase the severity of erectile dysfunction.

erection is declining, and not when it is interfering with penetrative sex. If we consider the inability to penetrate as one of the components for the diagnosis of ED, we are losing the opportunity to diagnose ED at an earlier stage. In addition to reduced rigidity, people with ED have decreased frequency of erection, prolonged refractory period, increased threshold for erection, and inability to maintain erection (Figure 4).

However, sexual activity does not always mean penetrative sex. Even people who prefer masturbation (self-sex) also feel changes in rigidity when they develop ED, and it interferes with the pleasure and sexual satisfaction associated with masturbation.

THE PROPOSED DEFINITION OF ED

With this background, we define ED as "any reduction in the frequency, durability and/or rigidity of penile erection in an individual compared to the normal or best previous fully erected status or significant prolongation of the refractory period which may or may not affect the sexual performance and satisfaction". Any reduction implies minimal reduction to complete absence, which decides the severity and stage of ED.

ASSESSMENT OF ED

Asking the patient to score his erection on a 0 to 10 scale (where 0 denotes a completely flaccid state and 10 denotes the best and hardest erection) is one of the easiest methods to assess the hardness of erection (Figure 5). This self-reported erection score is simpler and easier to use even for the patient compared to the erectile hardness score, which scores EH on a 4-point scale[24].

Depending upon the severity, we propose 7 stages of ED based on the rigidity and ability to penetrate (Table 1). ED_{1-7} indicate different stages ranging from decreased rigidity without difficulty in penetration (stage 1) to a completely flaccid penis, where penetration is impossible (stage 7). This clinical staging is easy to use in day-to-day practice and can be used even by patients to express the severity of their ED. It also has the advantage of including even the early stages of ED, which is not there in the existing definition. This staging is useful not only to assess the severity of erection and, planning optimal treatment but also to assess the response to treatment.

CLASSIFICATION OF ED

We classify ED in different ways, depending upon various factors like duration, etiology, associated features, type, *etc.* (Table 2). It helps to assess the characteristics of ED and probable etiology in a particular patient and formulate a treatment plan. To diagnose ED, symptoms persist for a minimum duration of 6 months in all or almost all (75% to 100%) occasions as per the existing definition of DSM-5[22]. If the symptoms are less than 6 months in duration, it is called

Table 1 Clinical staging of erectile dysfunction and classification

Stages of ED	Description	Classification of ED	Sexual performance
ED_0	Normal rigidity, able to penetrate normally	Normal	Normal
ED_1	Reduced rigidity, able to penetrate normally	Early ED	Not interfering with sexual performance
ED_2	Reduced rigidity, able to penetrate with difficulty, always	Mild ED	May or may not interfere with sexual performance
ED_3	Reduced rigidity, able to penetrate with difficulty, most of the time		
ED_4	Reduced rigidity, able to penetrate with difficulty, rarely	Moderate ED	Interfering with sexual performance
ED_5	Markedly reduced rigidity, unable to penetrate	Severe ED	Unable to perform penetrative sexual activity
ED_6	Flaccid, unable to penetrate		
ED_7	Completely flaccid, unable to penetrate		

ED: Erectile dysfunction.

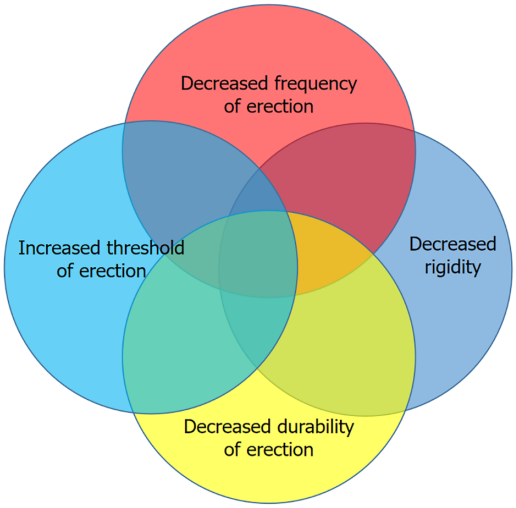

Figure 4 Different spectra of manifestation of erectile dysfunction.

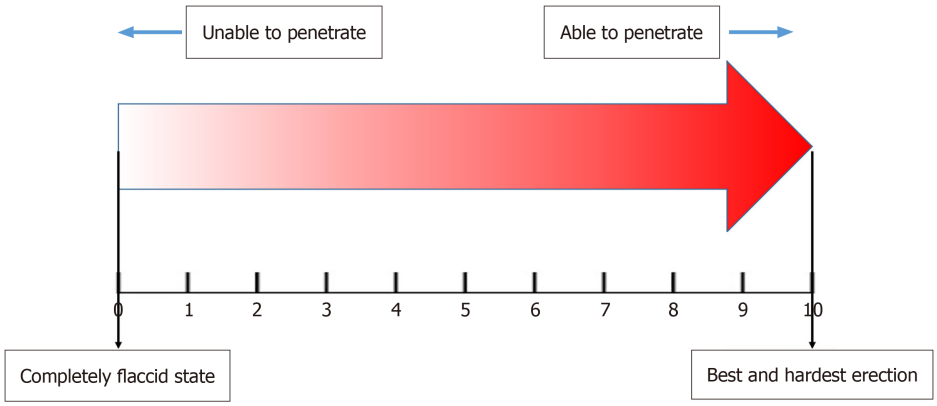

Figure 5 Self-Reported Erection Score -scoring of erection on a 0 to 10 scale and its relation to the ability to penetrate.

Table 2 Classification of erectile dysfunction

Clinical classification of ED
Depending upon the duration of the ED
Transient ED
Persistent ED
Depending upon the frequency of ED
Intermittent ED
Consistent ED
Depending upon the etiology of ED
Psychogenic ED
Organic ED
Vascular ED
Arteriogenic
Cavernosal (Venogenic)
Mixed
Endocrine ED
Anatomic ED
Neurologic ED
Iatrogenic ED
Combined ED
Depending upon the circumstances of the ED
Situational ED
Partner-related ED
Performance-related ED
Psychological distress- or adjustment-related ED
Global ED
Depending upon the course of the ED
Acute ED (Sudden onset ED)
Chronic ED (Indolent ED or gradually progressive ED)
Depending upon the associated health issues
Primary ED or idiopathic ED
Secondary ED
Depending upon association with another sexual dysfunction
Isolated ED (Simple ED)
Complicated ED (ED associated with another sexual dysfunction)
Primary ED with another sexual dysfunction
ED secondary to another sexual dysfunction
Depending upon dysfunction in the steps of erection
ED with initiation problem
ED with a maintenance problem
Depending upon the onset of ED
Lifelong ED
Acquired ED

Depending upon the domain of dysfunction
Decreased quality of erection
Decreased frequency of erection
Decreased durability of erection
Increased threshold for erection
Depending upon the type of sexual activity
ED associated with peno-vaginal intercourse
ED associated with peno-anal intercourse
ED associated with peno-oral intercourse
ED associated with self-sex (masturbation)
Depending upon the presence of symptoms
Asymptomatic ED
Symptomatic ED
Depending upon the severity of the ED
Early ED
Mild ED
Moderate ED
Severe ED
Depending upon the neurovascular mechanism of the erectile process
Failure to initiate (neurogenic)
Failure to fill (arterial)
Failure to store (venous)

ED: Erectile dysfunction.

transient ED. If ED is present for less than 75% of occasions, it is called intermittent ED. Based on the etiology, ED is classified as psychogenic, vascular, neurogenic, and endocrine ED. However, ED is most commonly due to mixed etiology. Situational ED occurs only with certain stimulation, situation, or partner, whereas global ED indicates the ED in all situations[25]. Depending upon the onset of symptoms, it can be sudden onset or gradually progressive. Gradually progressive ED usually indicates an organic cause. ED can be an isolated issue without any contributing illness (primary ED) or it can be secondary to various health conditions like atherosclerosis and diabetes (secondary ED). ED can be an isolated sexual dysfunction or it can be associated with another sexual dysfunction. ED is commonly associated with premature ejaculation (PE) and must be differentiated from PE. In ED loss of erection occurs before orgasm whereas in PE it occurs after orgasm. ED can be due to an initiation problem or maintenance problem. Venous leak results in soft, short-lived erections, with difficulty in achieving and maintaining a firm erection. Lifelong ED indicates that ED is present since the individual became sexually active whereas acquired ED develops after a period of normal erection. Lifelong ED is rare and can be due to clinically obvious anatomical or hormonal issues or psychological problems. Maintained nocturnal erection, ED of sudden onset, intermittent course, and short duration points towards psychological issues whereas ED of gradual onset, progressive nature, and long duration point towards the organic cause. ED interferes with all types of sexual activities including vaginal, anal, oral sex, and masturbation (self-sex). So, ED can be classified according to the type of sexual activity. The rigidity required for penetration varies from person to person and from the type of penetration (vaginal, anal, oral). So, a person having difficulty in one type of sexual activity can have near-normal performance in another type of penetrative sex.

CONCLUSION

ED is a common male sexual dysfunction. But is usually diagnosed only at later stages of the disease. Being a forerunner of cardiovascular disease, all the effort to be made to diagnose ED at the earliest. The proposed definition and staging will help to identify people with ED at an earlier stage of the disease. The proposed staging is very simple, easy to use, and can be used by both clinicians and even individuals suffering from ED worldwide.

FOOTNOTES

Author contributions: Raveendran AV designed the manuscript, collected the data, and wrote and revised the manuscript; the author read and approved the final version of the manuscript to be published.

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