Sexual Activity and Heart

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Introduction

Advances in medicine have been improving life expectancy significantly. On the other hand, there is a rising prevalence of chronic disease common to the aging process owing to the exponential growth of the elderly population. Improvements in quality of life, however, have been such that today one can remain active until a very advanced age, without organic impairments that have a major impact on functional capacity.

It is known that aging brings about changes in quantitative and qualitative sexual performance of both men and women, that erectile dysfunction has been a growing complaint in doctors' offices and clinics, and that medications used to treat cardiovascular diseases may affect sexual performance.

In view of this, doubts about the safety of sexual activity are common among patients and physicians alike and are often neglected in routine visits or upon hospital discharge following a cardiac event or procedure. Considered a "taboo" by most physicians and patients, sexual activity ultimately becomes stigmatized and is put aside by professionals and their clients. The patient does not ask and the doctor does not answer, and an unspoken pact of silence is made.

Mechanisms of erection

For sexual intercourse to occur, a series of cardiovascular, neural, and metabolic changes must take place. It should be emphasized that an association exists between increased heart rate, systemic blood pressure, and penile erection, determined by measurement of penile pressure, blood pressure at the abdominal aorta and heart rate during coitus in conscious rats[1].

Incidentally, erection is closely related to the cardiovascular system and occurs when the erectile tissue relaxes, increasing blood flow, a mechanism controlled by the autonomic nervous system modulation.

The penis derives its sympathetic nerve supply from the thoracolumbar spinal cord and, through noradrenaline release, smooth muscle cells are kept contracted and the penis, flaccid. The parasympathetic nervous system releases neuromediators that maintain these cells relaxed, allowing erection to occur. Penile erection is a reflex response to a stimulus from the genital region perceived by sensory fibers and conveyed by the dorsal nerve of the penis and the pudendal nerve, activating pudendal motoneurons and thereby causing the perineal striated muscles to contract. In addition, baroreceptors and chemoreceptors convey afferent information to the medulla through the IX and X cranial nerves.

As blood pressure increases, afferent information conveyed through the vagus nerve to the solitary tract also increases, the neurons of which have an excitatory effect on the caudal ventrolateral medulla. Their neurons, in turn, inhibit those of the rostral ventrolateral medulla, which tonically activate preganglionic motoneurons at the origin of vasoconstriction. A decrease in blood pressure occurs when motoneurons from the caudal ventrolateral medulla inhibits those of the rostral ventrolateral medulla, reducing sympathetic outflow to blood vessels.

As far as activity regulation is concerned, it has been suggested that the same nuclei located at the medulla, pons, and hypothalamus may contain premotor neurons projecting to bulbar motoneurons or from the spinal cord that control a wide population of autonomic neurons.

Nitric oxide (NO) may play a role in the central control of erection and in cardiovascular changes. Injection of nitric oxide donors into the rostral medulla of anesthetized rats attenuates renal nerve activity and thereby lowers systolic blood pressure. Injection into the caudal ventrolateral medulla, however, raises the systolic pressure.

In addition to nitric oxide, other systems originating in the medulla and pons are likely to have an autonomic influence through serotonina, noradrenaline, adrenaline, and dopamine release.

The brain has a key role in cardiovascular and erectile control. Some hypothalamic areas are thought to integrate and control the many autonomic pathways. It is known that stimulation of the preoptical area facilitates sexual activity, increases intracavernous pressure and decreases blood pressure.

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Some physiological aspects of sexual activity

Sexual activity can be divided into four phases, namely: excitement, plateau, orgasm, and resolution. Maximal energy expenditure during sexual intercourse occurs at orgasm, when oxygen uptake reaches its peak, returning to baseline levels within about two or three minutes.[2] "Marital sexual activity" is often compared to exercise involving energy expenditure of approximately 2 to 3 METs during the preorgasmic phase and 3 and 4 METs during orgasm. However, this varies widely among individuals. Virtually all studies we reviewed take for granted the classic relationship VO_2/HR, in which a "steady state" is thought to occur during sexual intercourse, something that cannot be confirmed, especially in a multifactorial activity such as sex between human beings. Most times, metabolic and cardiovascular responses during sexual activity seem to be more related to arousal than to the physical exertion itself. This distinction involves important aspects in the way cardiovascular tolerance for sex should be effectively evaluated.

Studies performed in the 1960s[3] examined changes in double-product (heart rate *versus* systolic blood pressure) during marital sexual intercourse in healthy men and determined that, in the positions evaluated (the missionary position – man-on-top – and the woman-on-top position), exertion during sexual intercourse corresponds to that posed by a physical activity involving mild-to-moderate energy expenditure. At the peak of orgasm, mean maximal heart rate was 114 bpm (standard deviation of 14 beats), and mean maximal blood pressure, 163/81 mmHg. Bohlen et al[4] indirectly measured energy expenditure in four different sexual modalities and found a peak oxygen uptake of 3.3 METs for the missionary position; the other modalities evaluated (woman-on-top, self-stimulation, and partner stimulation) showed even lower expenditures (2.5, 1.8 and 1.7 METs, respectively). It is worth noting that this energy expenditure is comparable to that of many daily activities, as showed in Table I. Nevertheless, this information cannot be extrapolated, because there are no data in literature on energy expenditure required by other sexual modalities (e.g, extramarital sexual activity, oral sex, homosexual activity, among others). Additionally, it must be mentioned that 3 METs can represent considerable effort for the elderly, corresponding to an oxygen uptake nearly 80% of VO_2 max, whereas in a thirty-year-old man this uptake is around 30% of VO_2 max.

In further regard to age group, the impact of the natural aging process should always be taken into account, since it also changes genitourinary physiology. Over time, men experience fewer spontaneous erections and need more stimulation to get a full erection. The refractory period also lengthens, but, curiously enough, erection seems to last longer with age[5]. As already stated, prevalence of erectile dysfunction increases exponentially with advancing age, affecting approximately 30% of men between 40 and 70 years [6,7] and 75% of octogenarians[6].

Table I – Estimated oxygen consumption for some activities (expressed in METs)

Activity	METs
Walking up to 3.5 km/h	2
Walking up to 5 km/h	3
Pre-orgasmic sexual activity	2-3
Sexual activity during orgasm	3-4
Running 10 km/h	6-7
Fourth stage of the Bruce protocol	13

Available data on different aspects related to female sexual physiology are very scant, but there is no reason to believe there are great variations between genders, except that women can experience multiple orgasms during the same sexual intercourse and also the great prevalence of anorgasmia, particularly in the most advanced age groups.

Impact of cardiovascular diseases on sexual activity

Cardiovascular diseases affect patients' sexual activity, and most often represent a complicating factor. Basically, this may be attributed to two primary reasons: 1) diagnosis of a heart condition and all the psychological implications that such "branding" incurs, such as anxiety, fear of death, and restricted physical activity; 2) the need to use several drugs capable of producing adverse effects that compromise sexual performance (especially by triggering erectile dysfunction and/or loss of libido).

Management of cardiac patients includes a large array of agents and procedures that are invasive in varying degrees. These procedures produce different levels of restriction to physical activity and, with it, different impact on sexual life. Following a cardiac diagnosis or procedure, it has been estimated that about 25% of the patients resume their normal sexual activity, with the previous frequency and intensity. Half of the patients return to their sexual activity at a reduced level concerning frequency and/or intensity, and the other 25% do not resume any sexual activity at all.[8] Such numbers represent a grimmer spectrum regarding cardiac failure. Approximately 40% of the men in New York Heart Association functional class III say they are unable to be sexually active[5]. There are several explanations for reduced sexual activity following cardiac events, among them are fear of coital death or reinfarction, dyspnea, anxiety, angina pectoris, exhaustion, changes in sexual desire, depression, loss of libido, impotence, partner's anxiety or concern, and feeling of guilt[7].

During sexual activity, HR and BP increase as in any other aerobic physical activity. The question is whether this increase is exaggerated and potentially dangerous.

Moreover, it is necessary to know if conventional antianginal therapy prescribed for the management of pain or discomfort at exertion may have the same beneficial effect during sexual activity[9,10,11].

Drugs used for the management of cardiovascular condition and its relation to sex

Virtually all classes of drugs used to treat cardiovascular diseases can affect sexual activity, and a not negligible percentage of sexual disorders may be caused by the agents used. Antihypertensive and diuretic medications are the most common causes of drug-induced sexual disorders[7]. Table II shows a non-stratified overview of sexual disorders and agents most frequently used.

Yet, some medications linked to "iatrogenic sexual disorders" may also facilitate the sexual life of cardiac patients. The use of beta-blockers, for example, has abolished angina symptoms in 65% of patients with stable angina who reported pain during sexual activity[12].

It is important to say, however, that in the great majority of studies the analyses are performed without the patient being tested during antianginal therapy, and so it is difficult to make a more accurate evaluation in cardiac patients using these medications.

Erectile dysfunction

Aiming at measuring erectile dysfunction prevalence in Brazil and three other countries (Italy, Japan, and Malaysia), in addition to studying its association with demographic characteristics and other medical conditions, through use of a questionnaire the authors assessed a sample of six hundred men, age 40 to 70, in each country[13]. Prevalence of age-adjusted dysfunction classified as moderate-to-complete was 34% in Japan, 22% in Malaysia, 17% in Italy, and 15% in Brazil. Higher risk for erectile dysfunction was also related with diabetes, heart diseases, lower urinary tract symptoms, smoking, and depression, in addition to an increase of 10% per additional year of age. Its presence was inversely associated with high level of education and irregular patterns in exercising.

Phosphodiesterase-5 inhibitors (PDE-5) and cardiovascular risk

In patients with severely obstructed vessels, myocardial flow depends on perfusion pressure, and a sharp decrease in BP may produce major ischemia and infarction. There is no evidence that phosphodiesterase-5 inhibitors improve the risk of acute myocardial infarction (AMI), although enough evidence suggests a slight increase associated with sexual activity (these drugs would indirectly raise the risk of events, because by allowing erection they expose men to sexual activity).

Sildenafil is an oral phosphodiesterase inhibitor that enhances erectile function and was the precursor of its class. Sildenafil requires preserved libido and sexual stimulation to be effective, an association that results in nitric oxide release into the corpus cavernosum of the penis, stimulating guanylate cyclase and the subsequent formation of cyclic guanosine monophosphate, a substance that promotes smooth muscle relaxation in the arteries, arterioles, and sinusoids of the corpus cavernosum. This increases blood supply and causes

Table II – Types of sexual changes and drugs involved

Erectile dysfunction	Drugs involved
Impotence	Hydrochlorothiazide, spironolactone, methyldopa, clonidine, reserpine, guanethidine, prazosin, beta-blockers, digoxine, disopyramide, propafenone, flecainide, amiodarone, sotalol, ACE inhibitors, losartan, valsartan, clofibrate, gemfibrozil
Decreased libido	Hydrochlorothiazide, spironolactone, methyldopa, clonidine, reserpine, guanethidine, propanolol, clofibrate, gemfibrozil
Ejaculatory difficulty	Methyldopa, reserpine, guanethidine, clonidine, phenoxyibenzamine, phentolamine, labetalol
Gynecomastia	Spironolactone, methyldopa, clonidine, digoxine
Hirsutism	Spironolactone
Menstrual irregularities	Spironolactone
Priapism	Prazosin, labetalol, hydralazine
Doença de Peyronie	Propranolol, Metoprolol
Anorgasmia	Clonidina
Lactorréia	Metildopa
Inibição da lubrificação vaginal	Hidroclorotiazida

Percentage of each symptom relative to the cited drug is not specified in the table

erection (phosphodiesterase-5 is the predominant enzyme in the urogenital region).

Literature abounds with studies using sildenafil in different subgroups of patients[14,15,16]. In the study by Morales et al, this agent did not increase the incidence of major cardiovascular events or AMI in a clinical trial setting. Sildenafil has also been shown to be effective in men with established coronary artery disease, hypertension, diabetes, and erectile dysfunction of nonvascular etiology, as well as psychogenic erectile dysfunction.

Sildenafil was well tolerated in patients with stable heart failure and erectile dysfunction, in addition to being effective in the management of erectile dysfunction *per se* in this group of patients. Curiously enough, in a crossover clinical trial performed in our country and published in Circulation on August 2002, sildenafil improved exercise capacity and reduced heart rate during exercise[17]. Theoretically, this finding suggests that this agent may decrease myocardial oxygen consumption during sexual activity.

Another drug that has been proven effective in the management of erectile dysfunction is tadalafil, a potent, selective phosphodiesterase-5 inhibitor[8]. Major improvements have been observed in patients with organic, psychogenic, or mixed sexual dysfunction. In a recently published study, 83% of the men treated with tadalafil reported improved erections compared with 20% of the patients in the placebo group; success rate occurred mostly between 4 and 36 hours following the use of tadalafil[19].

Men with diabetes mellitus have shown significant improvement in erection rate with tadalafil, irrespective of the degree of dysfunction[20]. Nevertheless, similar to other phosphodiesterase-5 inhibitors, tadalafil should not be administered in combination with organic nitrates, because of the potential hypotensive interaction between these agents[21,22]. Of note, however, is that phosphodiesterase-5 inhibitors have not been consistently tested in patients with cerebrovascular disease and unstable angina or angina of recent onset, nor in patients with severe arrhythmias.

Another treatment option for erectile dysfunction is the use of a penile prosthesis. These prostheses still are a valid and effective therapeutic alternative[23]. Although complications rates are low, the patient must be informed that penile prosthesis infection is the primary risk of this type of treatment, occurring in 3% of cases and requiring both device removal and appropriate antibiotic therapy[24].

A recent study reported that the use of sildenafil in patients with penile prosthesis significantly increased sexual satisfaction when compared with the implant alone; hence this association may be another alternative for these individuals[25].

Sexual activity risks and cardiovascular risk stratification

Studies suggest that a heart disease patient that can climb one or two flights of stairs can keep his marital sexual life without running further risk or even experiencing cardiac symptoms[26]. Yet, it has been postulated that the risk of having a myocardial infarction during sexual activity is three times greater than in other situations involving similar energy expenditure[27,28,29]. Therefore, it is important to bear in mind that cardiovascular symptoms during sex rarely occur in patients who had no similar symptoms during exercise stress testing, especially if they achieved an equivalent of 6 METs and remained asymptomatic and with no electrocardiographic changes indicative of ischemia.

In order to establish guidelines for sexual activity practice, patients can be classified according to their clinical condition[6]: a) *Patients at low risk* for cardiovascular disease are those classified as follows: asymptomatics, with less than three risk factors for CAD (excluding gender), controlled hypertension, class I or II stable angina according to the Canadian Cardiovascular Society (CCS), successful coronary revascularization, history of uncomplicated AMI, mild valvular disease, CHF (LV dysfunction and or NYHA I). These patients can be encouraged to resume sexual activity or receive treatment for sexual dysfunction. B) *Patients at intermediate risk:* at least three risk factors for CHD (excluding gender), class II or III stable angina according to CCS, recent AMI (> 2 weeks and < 6 weeks), LV dysfunction and/or NYHA class II CHF, noncardiac sequel from atherosclerotic disease (AVC and/or peripheral vascular disease). These patients should undergo a thorough cardiac evaluation before resuming sexual activity. C) *Patients at high cardiovascular risk*: presence of unstable or refractory angina, uncontrolled hypertension, NYHA class III-IV CHF, recent AMI (<2 weeks); high-risk arrhythmias, severe cardiomyopathies, moderate-to-severe valvular disease. For these patients sexual activity should be delayed until they are stabilized for their heart condition, since it poses a significant risk. They must get the cardiologist's clearance before resuming sexual life, because risk may outweigh benefit.

Sex as physical activity

Sexual activity should be viewed as any other physical activity and, therefore, coital death, as well as exercise-related death, is a rare event that accounts for 0.6 of all cases of all sudden death[8,31]. In these cases, some common factors are noted that help explain this specific event. Most deaths occurred among men involved in extramarital relationship, with partners about 20 years

younger than their customary partner and after excessive eating, usually associated with excessive drinking. A German observational study conducted during the 1990s[32] evaluated findings in more than 26 thousand autopsy studies performed over 27 years and found 48 cases of death during sexual activity. The overwhelming majority were men in the 60 to 66 age group, and myocardial infarction was the main cause of death. The female sample was extremely small, and death was predominantly caused by cerebrovascular events. Seventy-five per cent of the men died during extramarital relationship, mostly with young prostitutes (women younger than 30).

Overall, the risk of myocardial infarction triggered by sexual activity is also thought to be low. Approximately 3% of the patients with acute myocardial infarction report sexual activity in the two hours preceding the onset of symptoms, but in only 0.9% of the cases sexual activity may be considered as a triggering factor. The relative risk of myocardial infarction occurring in the 2 hours following sexual intercourse is 2.5, whether or not the individual has a history of heart disease. This risk is significantly lower in individuals who are regularly engaged in physical activities[27,28].

In patients with established coronary artery disease, coitus, when compared to vigorous physical activity and intense emotional response, represents low risk for precipitating myocardial infarction. Moreover, compared with METs from daily activities, total body oxygen demand and increased myocardial oxygen demand during sexual activity are modest and brief (vigorous sexual activity can increase energy expenditure from 5 to 6 METs).

Patients with stable angina under optimal treatment seem not to show significant increase in cardiovascular risk during sex. However, a not neligible percentage of these individuals will experience erectile dysfunction, just as patients with erectile dysfunction will likewise often have one or more coronary artery disease risk factors. Of importance is that erectile dysfunction affects the same age group as angina pectoris and in itself is a risk factor for coronary artery disease (in addition to being more common in the presence of diabetes, heart disease and hypertension). On the other hand, patients revascularized by angioplasty/stenting or coronary artery bypass grafting (CABG) with diagnosis of stable angina but asymptomatic at the moment of sex do not have increased risk for cardiac events during sexual activity. No data was found in literature about homosexual relationships, yet, in theory, long-term homosexual relationships should not be counseled otherwise.

The risk of cardiac event in patients classified as at low-risk in normal daily activities is one in a million per hour. This risk doubles during sexual activity, increasing to two in a million per hour (and this risk only doubles within the two hours following sex). Patients with nonselected coronary artery disease and most post-AMI patients have a ten-fold risk during sex (which corresponds to 20 chances per million per hour).

A relevant point must be considered here. The implementation of a regular, consistent physical exercise program together with aggressive changes in risk factors may yield a significant reduction in death risk or coital event, similar to the impact of these same nutritional-hygienic measures on the daily risk of these cardiac patients.

According to the current management of myocardial infarction, a pre-hospital discharge evaluation of cardiovascular risk is mandatory. It is therefore desirable that all patients undergo some risk stratification (invasive or noninvasive), even if it is by means of a submaximal exercise test (ergometry or ergospirometry). This test is intended to reach an oxygen uptake similar to the one the patient will reach during his usual physical activities.

As mentioned previously, the correlation between induced ischemia demonstrated during submaximal exercise stress test and sexual activity has already been tested in patients with stable angina[30]. All patients that had symptomatic or silent ischemia, shown by ST-segment depression on 24-hour holter monitoring, experienced the same symptoms during exercise stress test, demonstrating the excellent negative predictive value of this propedeutic method.

Regular exercising seems to have a significant protective effect. Therefore, physicians should encourage the patient's participation in cardiac rehabilitation programs, either supervised or unsupervised. Aerobic exercise reduces both the cardiac work required during sexual activity and the risk of myocardial infarction triggered by sexual activity. Of course, in the generalistic context of these orientations there will always be exceptions. It must be remembered that patients at higher risk for AMI should undergo thorough cardiac evaluation before engaging in physical activity practices, including sexual activity. For some of these patients, a mere exercise tolerance test may help doctors to evaluate cardiac safety of sexual activity and tailor recommendations according to the case.

Although no specific data are available on clock time of sexual intercourse and risk for cardiovascular events, by analogy and taking into account what has been published in the literature concerning the time of the day when the cardiac patient performs his physical activity (the higher risk is lack of exercise; regular exercise is beneficial in the morning, in the afternoon or at night), it is believed that the stable, active cardiac patient is not at higher risk, no matter when sexual intercourse occurs.

Finally, the more regular the individual's physical activity, and therefore his aerobic conditioning, the less likely coitus will represent a predisposing factor for a cardiovascular event. Improved physical fitness has been associated with lower heart rate and systolic volume, as well as with a beneficial effect on other cardiovascular

parameters, regardless of the submaximal level of exercise to which the individual is exposed. Thus, both cardiac and noncardiac individuals who are physically fit show a protective factor for events in general, in addition to being more protected from potential AMI and other coronary syndromes that may be triggered by sexual activity.

"Sexual counseling"

Patients must be oriented on sexual activity just as they are instructed on return to work and participation in exercise programs. The spouse should be informed as much as possible on the partner's condition. Recommendations should include how to reduce energy expenditure during sexual intercourse. Sexual activity should be avoided after meals, after excessive alcohol intake or in extreme temperatures, as well as at times of marked fatigue[7]. Within the first month following heart surgery, the partner's body weight should be avoided on the surgical scar. Cardiac symptoms during sexual activity are, most frequently, related to tachycardia, and heart rate control during exercise is critical to the treatment's success[7]. The use of nitrates before sexual intercourse is useful to control symptoms and reduce fear of the sexual performance being compromised by angina[33].

Finally, it must be emphasized that the use of nitrate is formally contraindicated in patients under sildenafil, vardenafil or other phosphodiesterase-5 inhibitors used in the treatment of erectile dysfunction, because of the potentially fatal hypotensive reaction[34].

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