Normal male sexual function: emphasis on orgasm and ejaculation

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Orgasm and ejaculation are two separate physiological processes that are sometimes difficult to distinguish. Orgasm is an intense transient peak sensation of intense pleasure creating an altered state of consciousness associated with reported physical changes. Antegrade ejaculation is a complex physiological process that is composed of two phases (emission and expulsion), and is influenced by intricate neurological and hormonal pathways. Despite the many published research projects dealing with the physiology of orgasm and ejaculation, much about this topic is still unknown. Ejaculatory dysfunction is a common disorder, and currently has no definitive cure. Understanding the complex physiology of orgasm and ejaculation allows the development of therapeutic targets for ejaculatory dysfunction. In this article, we summarize the current literature on the physiology of orgasm and ejaculation, starting with a brief description of the anatomy of sex organs and the physiology of erection. Then, we describe the physiology of orgasm and ejaculation detailing the neuronal, neurochemical, and hormonal control of the ejaculation process. (Fertil Steril® 2015;104:1051–60. ©2015 by American Society for Reproductive Medicine.)

Key Words: Erectile function, male sexual function, ejaculation, orgasm

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Ejaculatory dysfunction is one of the most common male sexual dysfunctions that is often misdiagnosed or disregarded. At present, there is no definitive cure for ejaculatory dysfunctions (1). New research on the physiology of ejaculation keeps emerging to identify targets of treatment. However, knowledge about this topic is still lacking. In the present article, we summarize the current literature on the physiology of ejaculation. We describe the anatomy of the organs involved and the erection physiology. We discuss the physiology of orgasm and ejaculation as two separate physiological processes. In addition, we describe the neurochemical and hormonal regulation of the ejaculation process.

FUNCTIONAL ANATOMY OF THE MALE GENITAL ORGANS

The male genital system consists of external and internal reproductive and sexual organs such as the penis, prostate, epididymis, and testes. Figure 1 shows the gross anatomy of the ejaculatory structures. Table 1 provides a summary of the functional anatomy of these organs (2–5).

PHYSIOLOGY OF ERECTION

The penile erection results from complex neurovascular mechanisms. Several central and peripheral neurological factors in addition to molecular, vascular, psychological and endocrinological factors are involved, and the balance between these factors is what eventually determines the functionality of the penis. In this section, we summarize some of those mechanisms.

Cerebral Control

Cerebrally controlled penile erections are induced through erotic visual stimuli or thoughts. The main cerebral structures involved in erection are contained within the medial preoptic area (MPOA) and paraventricular nucleus (PVN) in the hypothalamus (6). Dopamine is the most important brain neurotransmitter for erection, likely through its stimulation of oxytocin release (7). Another important neurotransmitter is norepinephrine, which is demonstrated through the erectogenic effect of the α-2 agonist (Yohimbine) (8). Several other brain neurotransmitters are involved in the erection process to varying degrees such as nitric oxide (NO), α-melanocyte stimulating hormone (α-MSH), and opioid peptides (9).

Autonomic Control

Parasympathetic stimulation is the main mediator for penile tumescence,

Received July 15, 2015; revised August 17, 2015; accepted August 26, 2015; published online September 16, 2015.
A.A. has nothing to disclose. B.N.B. has nothing to disclose. T.F.L. has nothing to disclose.
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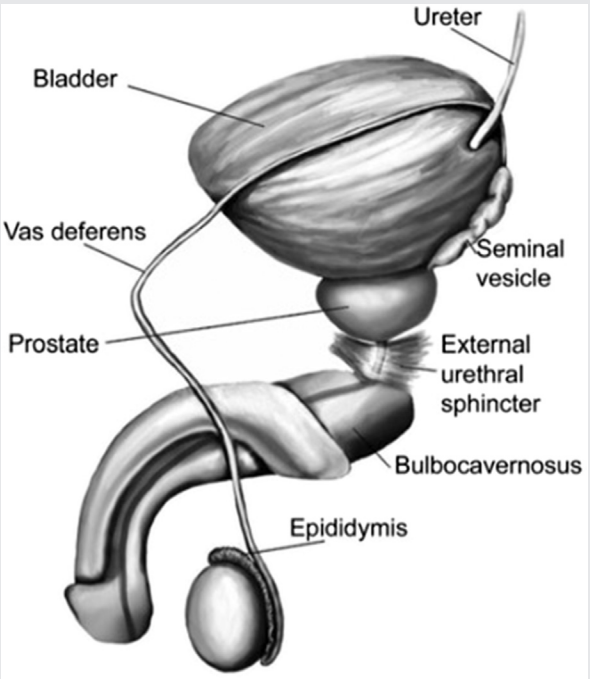
Fertility and Sterility® Vol. 104, No. 5, November 2015 0015-0282/$36.00

http://dx.doi.org/10.1016/j.fertnstert.2015.08.033

FIGURE 1



Gross anatomy of the ejaculation structures. (Reprinted with permission from Sheu G, Revenig LM, Hsiao W. Physiology of ejaculation. In: Mulhall JP, Hsiao W, eds. Men's sexual health and fertility: a clinician's guide. New York: Springer; 2014:15.)

Alwaal. Normal male sexual function. Fertil Steril 2015.

although central suppression of the sympathetic nervous system also plays a role. Parasympathetic supply to the penis is derived from the sacral segments S2-S4 (10). However, patients with sacral spinal cord injury still maintain erections through psychogenic stimulation, although of less rigidity than normal. These psychogenic erections do not occur in patients with lesions above T9 (11), suggesting that the main mechanism for these erections is central suppression of sympathetic stimulation (12). Patients with lesions above T9 still may maintain reflexogenic erections. This implies that the main mechanism for reflexogenic tumescence is the preservation of the sacral reflex arc, which mediates erection through tactile penile stimulation (13, 14).

Molecular Mechanisms

The penis at baseline is in a flaccid state maintained by the contraction of corporal smooth muscles and constriction of cavernous and helicine arteries leading to moderate state of hypoxia with partial pressure of oxygen of 30–40 mm Hg (15). During sexual arousal, NO is released from cavernous nerve terminals through the action of neuronal NO synthase (16). The NO activates guanylate cyclase, which in turn converts guanosine triphosphate to cyclic guanosine monophosphate (15, 17), leading eventually to smooth muscle relaxation and vasodilation (18). Although the initiation of tumescence is through neuronal NO synthase, the maintenance of erection is through endothelial NO synthase (19). The eventual smooth muscle relaxation and vasodilation results in blood flowing into the paired corpora and filling of the sinusoids, with increased intracorporal pressure (to >100 mm Hg during full erection) and compression of the subtunical venules, markedly reducing the venous outflow (13).

PHYSIOLOGY OF ORGASM

There is no standard definition of orgasm. Each specialty such as endocrinology or psychology examines this activity from each one's perspective, making it difficult to reach a consensus on the definition. Orgasm is generally associated with ejaculation, although the two processes are physiologically different (20). Certain physiological features are associated with orgasm, including hyperventilation up to 40 breaths/min, tachycardia, and high blood pressure (21). In fact, faster heart rate was found to be an indicator of "real" male orgasm during intravaginal intercourse, differentiating it from "fake" orgasm (22). Orgasm is also associated with powerful and highly pleasurable pelvic muscle contractions (especially ischiocavernosus and bulbocavernosus) (23), along with rectal sphincter contractions and facial grimacing (21). There is also an associated release and elevation in PRL and oxytocin levels after orgasm; however, the significance of this elevation is not entirely clear (24).

Studies using positron emission tomography, which measures changes in regional cerebral blood flow, have identified areas of activation in the brain during orgasm. Primary intense activation areas are noted to be in the mesodiencephalic transition zones, which includes the midline, the zona incerta, ventroposterior and intralaminar thalamic nuclei, the lateral segmental central field, the suprafascicular nucleus, and the ventral tegmental area. Strong increases were seen in the cerebellum. Decreases were noted at the entorhinal cortex and the amygdale (25).

Quality and intensity of orgasms are variable. For instance, short fast buildup of sexual stimulation toward orgasm is associated with less intense orgasms than slow buildup. Early orgasms are less satisfying than later orgasms in life as the person learns to accept the pleasure associated with orgasms. Lower levels of androgen are associated with weaker orgasms, such as in hypogonadism or in older age (20). It has been suggested that pelvic muscle exercises, particularly the bulbocavernosus and ischiocavernosus muscles, through contracting those muscles 60 times, 3 times daily for 6 weeks will enhance the pleasure associated with orgasm (20). However, the effort and time associated with such exercises prevent their utilization. The orgasm induced through deep prostatic massage is thought to be different from the orgasm associated direct penile stimulation. Although penile stimulation orgasms are associated with 4–8 pelvic muscle contractions, prostatic massage orgasms are associated with 12 contractions. Prostatic massage orgasms are thought to be more intense and diffuse than penile stimulation orgasms, but they require time and practice and are not liked by many men (20, 26, 27).

Following orgasm in men is a temporary period of inhibition of erection or ejaculation called the refractory period.