ANALYSIS OF HUMAN EJACULATION USING COLOR DOPPLER ULTRASONOGRAPHY: A COMPARISON BETWEEN ANTEGRADE AND RETROGRADE EJACULATION

ATSUSHI NAGAI, MASAMI WATANABE, YASUTOMO NASU, HIROKI IGUCHI, NORIHIRO KUSUMI, AND HIROMI KUMON

ABSTRACT

Objectives. To observe the phenomenon of human ejaculation dynamically using color Doppler ultrasonography.

Methods. Human ejaculation was observed using transrectal color Doppler ultrasonography in a healthy man and a patient with retrograde ejaculation. Ejaculation was induced manually with audiovisual sexual stimulation. The ejaculatory phenomenon was analyzed and compared with that of retrograde ejaculation.

Results. In the healthy man, the prostatic urethra flattened slightly and the bladder neck contracted just before expulsion. The ejaculatory stream spurted from the seminal vesicles to the bulbous urethra through the ejaculatory duct. In the patient with retrograde ejaculation, the ejaculatory stream from the seminal vesicles and inframontanal and distal prostatic urethras distended into a globular-shaped sac filled with semen. No seminal flow toward the bulbous urethra occurred. The semen remaining in the prostatic urethra began flowing slowly into the bladder.

Conclusions. Differences between antegrade and retrograde ejaculation can be clearly detected by color Doppler ultrasonography, providing a noninvasive method to diagnose ejaculatory disorders.

M ECHANISMS OF EJACULATION have been extensively elucidated in animal models. However, some points need further clarification. Only few reports have shed light on the dynamics of the phenomenon of human ejaculation. Only one study of transrectal ultrasound imaging in a healthy male has been reported to date. As for treatment of ejaculatory dysfunction, meager effective therapeutic methods are available because the ejaculatory phenomenon itself has not been studied in depth. We reported a case of retrograde ejaculation using color Doppler ultrasonography before and after transurethral collagen injection therapy. It was the first dynamic description of the phenomenon of retrograde ejaculation. In this report, we demonstrate the dynamics of human ejaculation using color Doppler ultrasonography and describe the differences between a healthy man and a patient with retrograde ejaculation.

MATERIAL AND METHODS

The antegrade ejaculatory phenomenon was observed in a 28-year-old healthy male volunteer. The patient with retrograde ejaculation was a 40-year-old man who had partial damage of the 12th thoracic vertebra due to a traffic accident 6 years previously. He had a slight gait disturbance and had to perform intermittent self-catheterization because of urinary retention. His erectile function remained normal, but retrograde ejaculation occurred, and he complained of a decrease in sexual satisfaction. No improvement in retrograde ejaculation resulted from conventional oral medication, including imipramine hydrochloride and antihistamines. To decide on surgical intervention, real-time imaging of ejaculation was performed using an ultrasound image-directed color Doppler system (Aloka SSD-2000) with a 7.5-MHz electroprobe (UST-669). The probe was introduced into the rectum with the patient in the left lateral decubitus position to visualize the bladder neck, prostate, and posterior urethra. Ejaculation was induced manually with audiovisual sexual stimulation. Ejaculation was observed twice in the healthy man.

From the Department of Urology, Okayama University Graduate School of Medicine and Dentistry, Okayama, Japan

Reprint requests: Atsushi Nagai, M.D., Department of Urology, Okayama University Graduate School of Medicine and Dentistry, 2-5-1 Shikata, Okayama, Okayama Prefecture 700-8558, Japan.

E-mail: atsnagai@md.okayama-u.ac.jp

Submitted: May 12, 2004, accepted (with revisions): September 9, 2004
RESULTS

The antegrade ejaculatory phenomenon was clearly observed by color Doppler ultrasound (Fig. 1). With manual penile stimulation, blood flow in the prostate and prostatic venous plexus increased gradually (Fig. 1B). The prostatic urethra distended slightly 3 and 5 seconds before expulsion of semen from the seminal vesicles. Flattening of the bladder neck with contraction of the prostate was seen 1 and 2 seconds after that (Fig. 1C). Next, the ejaculatory stream spurted from the seminal vesicles to the bulbous urethra through the ejaculatory duct (Fig. 1D,E). The flow toward the supramontanal portion of the prostatic urethra was observed 5 and 8 seconds after that, but no flow into the bladder was detected at this point (Fig. 1F). Rhythmic expulsion lasted for 12 and 13 seconds. During expulsion, the probe in the rectum moved; therefore, we had to hold the probe so as not to lose contact with the rectal wall. The bladder neck began to open 13 and 14 seconds after the end of expulsion, and a small volume of semen remaining in the prostatic urethra flowed into the bladder slowly (Fig. 1G). The prostatic urethra and bladder neck returned to normal 52 and 59 seconds after the end of expulsion, respectively (Fig. 1H).

In the patient with retrograde ejaculation, no abnormal findings of the prostate or bladder neck were detected by ultrasonography (Fig. 2A). Blood flow in the prostate and prostatic venous plexus increased, just as in the healthy man (Fig. 2B), and the prostatic urethra distended slightly, 1 second before (Fig. 2C), and the prostate contracted, just before expulsion with flattening of the bladder neck during expulsion. The inframontanal and distal prostatic urethrae began to dilate at the beginning of expulsion from the seminal vesicles (Fig. 2D). The ejaculatory stream spurted from the seminal vesicles into the prostatic urethra, and the inframontanal and distal prostatic urethrae distended into a globular-shaped sac filled with semen (Fig. 2E). The expulsion lasted 8 seconds; however, no flow toward the bulbous urethra occurred and, hence, no antegrade ejaculation occurred. Two seconds after the end of expulsion, the semen remaining in the prostatic urethra began flowing into the bladder slowly (Fig. 2F,G). The prostatic urethra and bladder neck returned to normal shape 117 seconds after the end of expulsion (Fig. 2H).
COMMENT

The human ejaculatory phenomenon was observed using endorectal ultrasonography by Gil-Vernet et al.\(^1\) In our series, we used color Doppler ultrasonography to analyze the ejaculatory phenomenon in a healthy man and a patient with retrograde ejaculation. It is the first successful attempt at observing and analyzing the total process of human ejaculation.

Classically, the phenomenon of ejaculation was thought to comprise three phases: emission, formation of a pressure chamber in the posterior urethra with bladder neck closure, and expulsion of semen. The emission was believed to be the movement of seminal fluid into the prostatic urethra. Gil-Vernet et al.\(^1\) reported that a decrease in echogenicity of the prostatic urethra during the pre-ejaculatory phase signifies the secretion and movement of prostatic fluid to the prostatic urethra, which in turn leads to the inevitability of expulsion. In our study, the healthy man's prostatic urethra distended 3 to 5 seconds before the start of seminal expulsion. This reinforces the phenomenon demonstrated by Gil-Vernet et al.\(^1\) Flattening of the bladder neck and contraction of the prostate were observed at the same time as dilation of the prostatic urethra, which is thought to create a pressure chamber during the second stage of ejaculation. Gil-Vernet et al.\(^1\) described these phenomena as a decrease in the distance between the anterior and posterior ledges of the bladder neck and a notable decrease in the echogenicity of the inner gland. The third stage of ejaculation, called expulsion, is the direct discharge of seminal fluid from the seminal vesicles to the bulbous urethra through the ejaculatory duct. Gil-Vernet et al.\(^1\) described this phenomenon as follows. The urethral lumen began to expand and its contents became heterogeneous, comprising fine, hyperechogenic particles in suspension. The particles moved rapidly, alternatively increasing and decreasing in speed, in a caudal direction, from the region of the verumontanum and through the membranous and bulbous urethra. They did not describe the movement from the seminal vesicles to the bulbous urethra. Unlike Gil-Vernet et al.,\(^1\) we used color Doppler ultrasonography and were able to visualize the direct flow of the semen from the seminal vesicles toward the bulbous urethra. This phenomenon is clearly different from the conventional concept of ejaculation. It has been hypothesized that the ejaculatory stream occurs because of compression of the seminal vesicles by the strong involuntary rhythmic contractions of the pelvic floor muscles.

In the patient with retrograde ejaculation, the blood flow increase in the prostate and dilation of
the prostatic urethra before expulsion were the same as in the healthy man. Contraction of the prostate and flattening of the bladder neck were also observed, but they were not as marked as in the healthy man. The dilation of the inframontanal urethra with semen and the absence of flow into the bladder during expulsion indicate that the bladder neck contraction prevented the flow of semen into the bladder, but the external sphincter did not relax, resulting in retrograde ejaculation. The causes for retrograde ejaculation may be the increased tone of the sphincter or the lack of coordination between the sphincter and the bladder neck during expulsion. Similar detrusor sphincter dyssynergia occurs in patients with spinal cord injuries. This patient also had been performing intermittent self catheterization owing to difficulty in urination, probably due to the same condition. At the end of expulsion, the semen remaining in the prostatic urethra began gradually flowing into the bladder. We postulated that the pressure chamber in the prostatic urethra propelled the semen into the bladder.

Secondary retrograde ejaculation occurs as a result of transurethral resection of the prostate, spinal injury, as in our patient, diabetes mellitus, or as a complication of pelvic visceral surgery. Drugs that increase the tone of the bladder neck muscles such as anticholinergic agents, alpha-adrenergic stimulators, and tricyclic antidepressants are used in the treatment of retrograde ejaculation. In our patient, conservative therapy did not result in the improvement of retrograde ejaculation. As for surgical treatment, bladder neck reconstruction and the Young-Dees operation are well known procedures for the correction of this condition. We successfully used bladder neck collagen injection, which is a recently described, minimally invasive technique, in our patient. The findings of the ejaculatory phenomenon we investigated might not be universal, because we only studied two individuals; however, we believe these findings will contribute to the clarification of the mechanism of human ejaculation and the future development of therapeutic methods for ejaculatory disorders.

CONCLUSIONS

The phenomenon of human ejaculation was clearly observed and analyzed using color Doppler ultrasonography in a healthy man and a patient with retrograde ejaculation. Noninvasive dynamic observation using Doppler ultrasonography can be successfully used to arrive at a diagnosis.

REFERENCES