

CASE REPORT

Low-frequency neuromuscular electrical stimulation as a treatment for anejaculation caused by iatrogenic injury of the abdominal aorta: a case study

Kefan Li^{1,†}, Qi Zhang^{2,†}, Ziheng Li³, Qiang Fu^{1,2,4,*}, Shuai Liu^{1,2,4,*}

¹Department of urology, Shandong Provincial Hospital, Shandong University, 250021 Jinan, Shandong, China

²Department of urology, Shandong Provincial Hospital Affiliated to Shandong First Medical University, 250021 Jinan, Shandong, China

³Second Department of Surgery, Shandong Rongjun General Hospital, 250014 Jinan, Shandong, China

⁴Key Laboratory of Urinary Diseases in Universities of Shandong (Shandong First Medical University), 250021 Jinan, Shandong, China

***Correspondence**

fuqiang@sdfmu.edu.cn

(Qiang Fu);

liushuai@sdfmu.edu.cn

(Shuai Liu)

† These authors contributed equally.

Abstract

Anejaculation is the inability to ejaculate during sexual activity, either in an antegrade or retrograde fashion. Both anejaculation following an iatrogenic injury of the abdominal aorta and the efficacy of low-frequency neuromuscular electrical stimulation (NMES) in treating anejaculation have been reported rarely. In this case report, we describe a patient who experienced anejaculation following an iatrogenic injury to the abdominal aorta and eventually regained normal ejaculation ability following treatment with NMES. The patient, a 23-year-old Chinese man, underwent laparoscopic varicocele ligation on both sides, during which he sustained a ruptured wound in the abdominal aorta from a 10-mm trocar. To stop the bleeding, he underwent abdominal aortic balloon catheter dilatation combined with covered stent implantation. However, 10 days after the endovascular interventions, the patient developed hemorrhagic shock and underwent emergency exploratory laparotomy and adventitial suture of the abdominal aorta. Despite normal erectile function since a week after the last surgery, the patient complained of anejaculation for a year during intercourse or masturbation. After receiving NMES treatment for over two months, the patient reported successful intravaginal ejaculation during intercourse, and the improvement persisted for a month after treatment. Altogether, these findings suggest that NMES could be a feasible, safe, and cost-effective treatment method for improving anejaculation and provides a novel option for patients with this condition.

Keywords

Anejaculation; Neuromuscular electrical stimulation; Iatrogenic injury; Abdominal aorta; Case report

1. Introduction

Anejaculation, also referred to as ejaculatory incompetence, is a sexual dysfunction that is relatively uncommon and characterized by the absence of ejaculation during sexual activity despite normal erectile function and orgasm [1]. It is often caused by spinal cord injury, retroperitoneal lymph node dissection, diabetes mellitus, transverse myelitis, multiple sclerosis, and psychogenic causes [2]. However, anejaculation following an iatrogenic injury to the abdominal aorta is rare. Anejaculation is defined as the inability to ejaculate during sexual activity or masturbation, despite normal erectile function or nocturnal emissions [1]. Although some effective outcomes for anejaculation have been reported with sex therapy, vibrator stimulation and electroejaculation [3], there is currently no known curative treatment for anejaculation.

Neuromuscular electrical stimulation (NMES) is a technique involving the application of electrical impulses or signals to evoke muscle contractions and a conservative treatment option for exercising the pelvic floor muscle and treating lower

urinary tract symptoms [4]. However, its role in the treatment of anejaculation has not been reported. Here, we present a case report of a patient with anejaculation who received NMES treatment and eventually recovered normal ejaculatory ability after an iatrogenic injury to the abdominal aorta.

2. Case presentation

A 23-year-old male presented to our urology outpatient clinic with complaints of anejaculation one year after undergoing laparoscopic varicocele ligation (bilateral) at his local hospital. During the establishment of pneumoperitoneum through a transumbilical puncture, a vascular rupture was inflicted in the abdominal aorta by a 10-mm trocar, resulting in contrast extravasation from the lower segment of the abdominal aorta proximal to the bifurcation of the iliac artery and a retroperitoneal hematoma. To address the bleeding, the patient underwent a procedure involving balloon catheter dilatation and covered stent implantation on the abdominal aorta. However, ten days after the endovascular interventions, the patient experi-

enced hemorrhagic shock and required emergency exploratory laparotomy. Arteriography revealed that the retroperitoneal hematoma had increased in size, with an approximately 5 mm defect observed in the adventitia of the abdominal aorta proximal to the bifurcation of the iliac artery. The defect was then repaired by suturing the adventitia with a 5-0 vascular suture. A week later, the patient reported anejaculation during intercourse or masturbation but with normal erections and no nocturnal emissions. He was only able to successfully ejaculate once, producing about 0.2 mL of semen with a concentration of 70.7×10^6 spermatozoa/mL and progressive sperm motility of 0% during masturbation. Post-orgasm urine tests were semen-negative, indicating that the patient did not have retrograde ejaculation. However, it was unclear what accounted for the extremely low progressive sperm motility. To determine the cause of the extremely low progressive sperm motility, it was suggested that the patient undergo testing for sperm DNA fragmentation if necessary. It was also considered that the long submission time of the semen sample could have affected sperm motility or that it could be a result of the operation itself [5].

A year after his surgery, the patient consulted the urology department at our hospital due to his continued lack of ejaculation during masturbation or coitus. He underwent a thorough clinical history inquiry and several examinations, including psychosexual counseling, genital and rectal examination, male genitourinary ultrasound, magnetic resonance imaging (MRI), and blood tests for sex hormones (serum prolactin, luteinizing hormone, follicle-stimulating hormone, and testosterone) and insulin-like growth factor-1 (IGF-1) to exclude psychogenic or anatomical causes [6]. These findings revealed no psychological or genitourinary anatomical disorders and that the patient had normal sexual desires. Moreover, the international index of erectile function-5 (IIEF-5) and audiovisual sexual stimulation and RigiScan test (AVSS-Rigiscan test) were also conducted to exclude ejaculation dysfunction induced by erectile dysfunction [7]. The patient had an IIEF-5 score of 23, and the AVSS-Rigiscan test indicated normal penile erectile function. However, a computed tomography angiography (CTA) performed twenty days after the iatrogenic injury of the abdominal aorta showed the presence of left iliac artery stenosis (Fig. 1). This could be attributed to the adventitia suture of the abdominal aorta being too close to the bifurcation of the iliac artery. The onset of anejaculation after the operation suggests it may have been a contributing factor. Additionally, aortoiliac operations could cause anejaculation due to damage to the sympathetic chains around the abdominal aorta. Therefore, we classified this patient as having anejaculation caused by vasa nervorum damage during an iatrogenic injury of the abdominal aorta proximal to the bifurcation of the iliac artery. Since the patient had no desire for fertility, he declined vibrator stimulation and electroejaculation to retrieve spermatozoa for assisted reproduction technology.

After obtaining written informed consent from the patient, the first NMES treatment was administered on 01 December 2021. On the same day, the patient experienced nocturnal emissions but was still unable to ejaculate through masturbation. The NMES treatment involved a low-frequency electrical impulse (BioStim Pro, Foshan Shanshan Datang



FIGURE 1. Computed tomography angiography (CTA) demonstrates a covered abdominal aortic stent and left iliac artery stenosis. The white arrow represents a covered abdominal aortic stent; the red arrows represent left iliac artery stenosis.

Medical Technology Co. Ltd, Guangzhou, China) that stimulated the sacral nerve at the level of S2–S4 for 30 minutes daily. The stimulus frequency was gradually increased until the patient felt discomfort, and then the stimulation was stopped. The patient received stimulation at a frequency of 15 Hz and pulse duration of 320 μ s for optimal benefit (the scenario of treatment and device details are shown in **Supplementary Fig. 1**). The temperature changes during the NMES treatment were recorded using an infrared camera (TMT-9000B, Hangzhou XinHan Photoelectric Technology Co. Ltd, Hangzhou, China), and the data was analyzed using TMT-9000 Application Software (version 1.0.10.17, Hangzhou XinHan Photoelectric Technology Co. Ltd, Hangzhou, China).

Following two weeks of NMES treatment, the patient experienced his first ejaculation, comprising approximately 2 mL of semen. The results of the post-ejaculation urine tests were negative for serum. Despite continued NMES treatment, the patient still did not ejaculate during coitus but had occasional ejaculations during masturbation or nocturnal emissions. Notably, the infrared camera recorded a higher emission of radiative heat from the pelvic area after the NMES treatment (Fig. 2).

Remarkably, on 11 January 2022, the patient was able to ejaculate 4 mL of semen during intercourse. He continued re-

ceiving NMES treatment for a month, during which more successful ejaculations occurred during sexual intercourse. The infrared camera recorded an increase in the emission of radiative heat from the pelvic area after NMES treatment. On 08 May 2022, the patient successfully ejaculated 0.8 mL of semen with a concentration of 64.3×10^6 spermatozoa/mL and progressive sperm motility of 0.41% by masturbation. At the time of writing, the patient was still able to ejaculate through masturbation or intercourse. The treatment timeline of the case is depicted in Fig. 3.

3. Discussion

Anejaculation is a rare disorder that is not fully understood in terms of its causes, with potential main contributing factors comprising neurogenic or psychogenic factors, of which spinal cord injury (SCI) is the most commonly identified cause [8]. In the case study, anejaculation was observed one week after endovascular interventions and adventitial suture of the abdominal aorta. Postoperative angiography revealed left iliac stenosis. The temporal relationship between the onset of anejaculation and the operation suggests that it may be a potential precipitating factor. Additionally, previous literature has suggested that aortoiliac operations may cause anejaculation due to damage to the sympathetic chains around the abdominal aorta [9]. The patient underwent multiple operations around the abdominal aorta. Based on the available evidence, it is reasonable to classify the anejaculation as being due to damage to the vasa nervorum resulting from iatrogenic injury to the abdominal aorta. However, further studies are needed to examine this issue more closely.

Currently, there is no specific therapy available to cure anejaculation in patients. However, mobile health applications have been found to be useful in aiding and assisting male infertility patients [10]. For patients who undergo assisted reproduction technology, commonly used methods such as vibrator stimulation and electroejaculation can aid in sperm retrieval. Vibrator stimulation may be more effective for patients with upper motor neuron lesions caused by spinal cord injuries, especially for those with complete lesions [11]. However, side effects such as penile skin abrasions, swelling, and hypertension induced by autonomic dysreflexia may occur. Patients who do not respond to vibrator stimulation may benefit from electroejaculation, but it is a painful procedure that requires general anesthesia and may not be suitable for some patients [11]. Given these limitations, the reported patient decided to try NMES.

It is widely recognized that ejaculation is a physiological process that occurs in two phases: emission and expulsion. During ejaculation, rhythmic contractions of the bulbocavernosus muscle expel seminal fluid through the urethra and out of the penis [12]. In addition, there is substantial evidence to support the idea that pelvic floor dysfunction can contribute to various disorders, including but not limited to urinary incontinence, fecal incontinence, erectile dysfunction, premature ejaculation, delayed ejaculation, and others [13]. In this regard, NMES is a widely used method for strength training in healthy adults and for rehabilitating muscle function and mass in patients with muscle weakness or voluntary

muscle dysfunction [14]. It is a relatively new approach to improving and rehabilitating pelvic floor muscles. There are two available modes of NMES that can be used to stimulate the pelvic floor muscles: surface electrical stimulation (SES) and intravaginal electrical stimulation (IVES). SES involves placing an electrode pad on the skin over the sacral nerve, while IVES involves inserting an electrode into the vagina to directly stimulate the pelvic floor muscles. According to a previous study, both methods can significantly increase pelvic floor muscle strength [14]. In this present case report, the patient recovered ejaculation ability through intercourse even a month after undergoing NMES treatment. However, no similar studies have been reported in the literature regarding the use of NMES in treating anejaculation, and we could not rule out the possibility of unexplained functional or transient ejaculation postoperatively due to the lack of large-scale investigations. However, it is noteworthy that the infrared camera used to record the patient's pelvic temperature showed an increase in radiative heat emission after NMES. This non-invasive and robust indication of physiological dysfunction, known as infrared thermography (IRT), has sparked the interest of clinicians [15]. Infrared thermography (IRT) measures the infrared radiation emitted by a surface and converts its intensity into temperature readings. During muscle contraction, the energy generated is conducted to the skin through blood flow [16]. Previous research has shown that temperature changes recorded by IRT are related to the force of muscle contraction [17]. Therefore, in this study, IRT was used to evaluate the improvement caused by NMES. The process of ejaculation involves rhythmic, involuntary contractions of the periurethral skeletal muscle, which are mediated by motor fibers through the pudendal nerve from S2 to S4 [11]. Additionally, low-frequency electrical stimulation has been found to promote microcirculation and improve localized blood flow [18]. Based on the available evidence, it is reasonable to speculate that using cutaneous electrical nerve stimulation to stimulate the sacral nerve at the level of S2-S4 can enhance the rhythmic, involuntary contractions of the periurethral skeletal muscle. Electrical stimulation can also improve blood flow to the pelvic floor, which could contribute to the improvement of anejaculation. Furthermore, compared to vibrator stimulation and electroejaculation, NMES may offer a more "natural" ejaculation since no external devices are required during masturbation or intercourse.

This present study had some limitations that should be clarified. Since this was a case report, further studies involving a larger number of cases are needed to verify the effectiveness of NMES in treating anejaculation in other patients. Additionally, the mechanisms underlying the effectiveness of NMES in treating anejaculation are not yet fully understood; therefore, further large-scale prospective investigations are necessary to address these limitations.

4. Conclusion

In conclusion, we presented a case report of a male patient who developed anejaculation following an iatrogenic injury to the abdominal aorta and was successfully treated with NMES. Our findings suggest that NMES may be a safe and effective

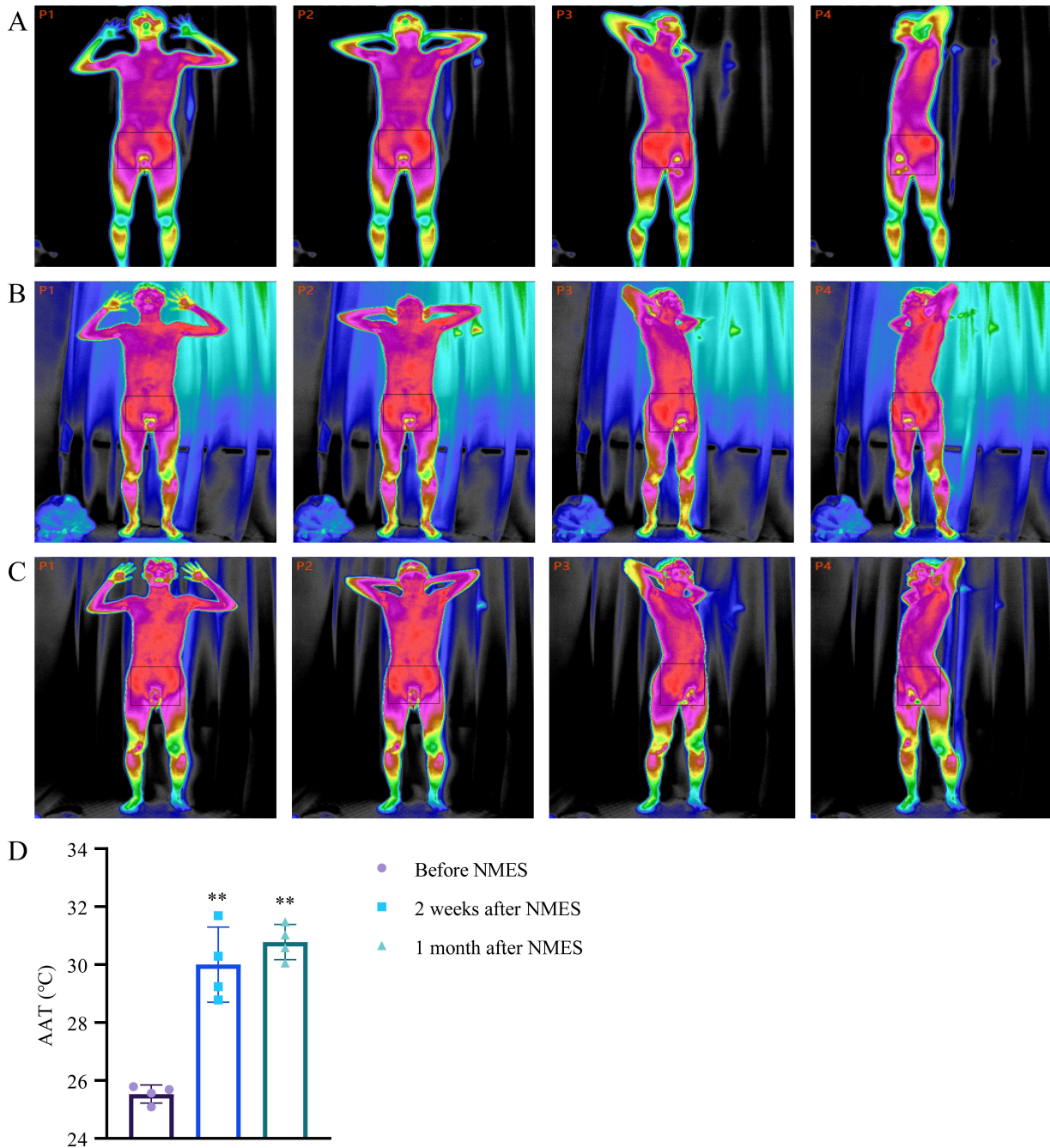


FIGURE 2. The thermal images and temperature changes before and after NMES treatment. (A). The thermal images at different body positions before NMES treatment. (B). The thermal images at different body positions two weeks after NMES treatment. (C). Thermal images at different body positions one month after NMES treatment. (D). NMES treatment increased the AAT (areas in the rectangular boxes) of the pelvic floor muscle. AAT, average absolute temperature; NMES, neuromuscular electrical stimulation.

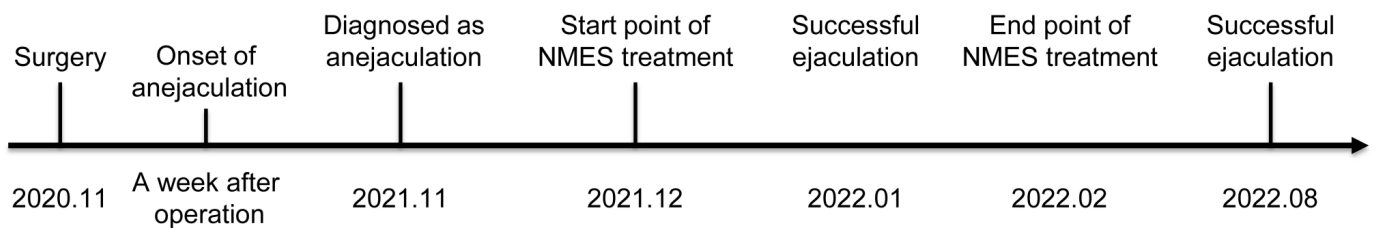


FIGURE 3. Treatment timeline of the patient. NMES, neuromuscular electrical stimulation.

treatment option for improving anejaculation, with the added benefit of providing a more natural ejaculation experience for patients who do not want to rely on external devices during sexual activity. This treatment method could be simple to implement and associated with low cost, making it a promising option for managing anejaculation. Further studies involving larger patient populations are necessary to confirm these findings and explore the underlying mechanisms of NMES in treating anejaculation.

AVAILABILITY OF DATA AND MATERIALS

The data are contained within this article (and supplementary material).

AUTHOR CONTRIBUTIONS

KFL, QZ and ZHL—contributed substantially to the conception and design, acquisition of data, and interpretation of data. KFL—drafted the article. QF and SL—revised it critically for important intellectual content, are the co-corresponding authors. KFL and QZ—are the co-first authors. All authors gave final approval for the version of the article to be published.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study protocol was reviewed, and the need for approval was waived by Shandong University Institutional Review Board. Written informed consent was obtained from the patient to publish on this case report and any accompanying images.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found, in the online version, at <https://oss.jomh.org/files/article/1718902737609867264/attachment/Supplementary%20material.docx>.

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