

## BASIC SCIENCE

## Dynamic Penile Corpora Cavernosa Reconstruction Using Bilateral Innervated Gracilis Muscles: A Preclinical Investigation

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### ABSTRACT

**Introduction:** Prosthesis-assisted penile reconstruction has been performed extensively to restore a cosmetically acceptable phallus. However, a large number of patients will undergo revision surgery for various prosthesis-related complications.

**Aim:** To develop a 1-stage prosthesis-free dynamic cavernosa reconstruction method using bilateral innervated gracilis muscles and to investigate the feasibility and reliability of the surgical design.

**Methods:** 10 fresh cadavers were dissected to assess the availability of bilateral gracilis muscles for functional cavernosa rebuilding. 11 mongrel female dogs were involved in the penile reconstruction surgery. The neophallus consisted of bilateral gracilis muscles as the neo-cavernosa, a right gracilis skin flap as the neourethra, and a lower abdominal flap with an anterior rectus sheath as the skin envelope and neo-tunica albuginea. The function and structure of the neo-phalli were assessed 7 months postoperatively.

**Main Outcome Measures:** The neurovascular pedicle length of the gracilis muscles and the volume of the gracilis venter musculi were measured in the cadaveric investigation. The average dimensions of the canine neo-phalli at rest and during electrostimulated erection were obtained and the muscular fatigue-resistant curve was drawn. Histologic evaluations also were performed.

**Results:** The neurovascular pedicle length and volume of the gracilis muscles were sufficient to yield a nearly normal appearance of the neo-cavernosa in the cadaveric and animal studies. The muscular fatigue-resistant curve demonstrated adequate length, stiffness, and duration of erection of the neo-phalli to accomplish normal coitus. Histologic evaluations showed an intact neourethra and nearly normal muscle structure in the inner layer of the canine neo-cavernosa, except for significantly increased amount of collagen fibers and type I/III collagen ratio in the outer layer of the neo-cavernosa. The percentage of type II (fatigue-prone) muscle fibers did not change significantly.

**Conclusion:** Our preclinical investigation proves that corpora cavernosa reconstruction using bilateral innervated gracilis muscles is technically feasible and functionally efficacious. **Yin Z, Liu L, Xue B, et al. Dynamic Penile Corpora Cavernosa Reconstruction Using Bilateral Innervated Gracilis Muscles: A Preclinical Investigation. Sex Med 2018;XX:XXX–XXX.**

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**Key Words:** Penile Reconstruction; Corpora Cavernosa Reconstruction; Erectile Function; Gracilis Muscle; Preclinical Study

### INTRODUCTION

As the number of patients with penile loss or gender dysphoria continues to increase, the demand for anatomic, functional, and

esthetic penile reconstruction is rising. Fortunately, with a better understanding of the male genital anatomy and evolving surgical procedures, penile reconstruction can be conducted successfully by various flap procedures and erectile prosthesis implantation,

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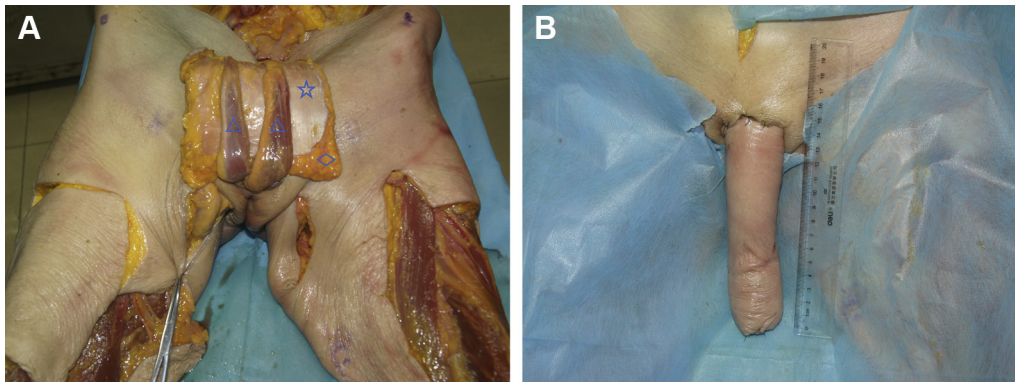
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**Figure 1.** Design of the dynamic corpora cavernosa reconstruction in the cadaveric study. Panel A shows the intraoperative design. The reconstructed penis consisted of bilateral gracilis muscles (triangles) as the neo-cavernosa and a unilateral island pedicled anterolateral thigh flap (rhombus) with part of the fascia lata (star) as the skin envelope and neo-tunica albuginea. Panel B show the postoperative outcome.

resulting in nearly normal urinary and sexual function.<sup>1–3</sup> However, prosthesis insertion for corpora cavernosa reconstruction must be performed in a 2nd stage after penile shaft reconstruction according to most surgeons.<sup>1</sup> In addition, the prosthesis implantation procedure is prone to multiple complications involving prosthesis extrusion, infection, and dysfunction, which could necessitate at least 1 revision surgery.<sup>4,5</sup>

Autologous costal cartilage implantation could be advantageous for patients who desire 1-stage prosthesis-free phalloplasty.<sup>6</sup> However, using the rod-like cartilage implant as static support for the neophallus cannot simulate the dynamic function of the penile cavernosa, which is characterized by a self-controlled directional volume switch for erection. In this respect, penile allotransplantation could offer an ideal solution for functional cavernosa reconstruction,<sup>7</sup> but the technique is still in its infancy, and many logistical, procedural, and ethical issues remain controversial, which renders the novel technique prohibitive for reconstructive surgeons.

The gracilis myocutaneous flap was introduced for 1-stage phalloplasty,<sup>8</sup> but the method does not have extensive application in total penile reconstruction because of the too bulky appearance of the neophallus. However, given its dynamic property and reliable anatomic features, the innervated gracilis muscle could be a technically ideal substitute for the corpora cavernosa. Thus, our preclinical study attempted to develop a 1-stage prosthesis-free dynamic corpora cavernosa reconstruction method using bilateral gracilis muscles and investigate the feasibility and reliability of the surgical design through cadaveric dissection and animal model research.

## METHODS

### Cadaveric Study and Dissection Techniques

The cadaveric study was approved by the ethics committee of the Plastic Surgery Hospital of the Chinese Academy of Medical Sciences (Beijing, China). 10 fresh cadavers were dissected at the Laboratory of Anatomy at the Peking Union Medical College

(Beijing, China) from February 2014 through June 2015. The average age of the 4 male and 6 female cadavers was 58.0 years (range = 38–73 years).

Dissections were performed to determine the feasibility and reliability of the novel cavernosa reconstruction design. The gracilis muscles and their vessels and nerve pedicles were dissected and measured to assess the availability for functional cavernosa rebuilding. The reconstructed penis consisted of bilateral gracilis muscles as the neo-cavernosa and a unilateral island pedicled anterolateral thigh (ALT) flap with part of the fascia lata as the skin envelope and neo-tunica albuginea (Figure 1, Supplemental Figure 1). Bilateral subcutaneous tunnels at the groin area were dissected, through which the muscles and skin flap were transferred to the pubic symphysis to fashion the neophallus. All findings were documented by digital photography.

### Animal Care

All animal care and experimental protocols were approved by the ethics committee of the Plastic Surgery Hospital at the Chinese Academy of Medical Sciences. 11 mongrel female dogs (11–13 months old, weight =  $17.4 \pm 2.2$  kg) were maintained on a commercial paste diet, given deionized water ad libitum, and kept in cages in a  $20 \pm 2^\circ\text{C}$  room at 40% to 60% relative humidity with a natural light-dark cycle.

All animals were subjected to penile reconstruction surgery according to the following surgical procedures. Intravenous access was established preoperatively for saline infusion to maintain fluid balance. Penicillin at a dose of 40,000 IU was given intramuscularly before surgery and the antibiotic was administered at the same dose once a day for 5 days postoperatively. Each dog after surgery was equipped with a large-sized Elizabethan collar to prevent the animal from biting and licking the surgical site. The animals were examined daily within 2 weeks after surgery until the wound healed completely. Postoperative complications, such as incision dehiscence and self-bite, were managed immediately once observed.

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