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REVIEW

Current status of laparoscopic and robot-assisted nerve-sparing radical cystectomy in male patients

Jian Huang*, **Xinxiang Fan**, **Wen Dong**

Department of Urology, Sun Yat-sen Memorial Hospital, Sun Yat-sen University, Guangzhou, China

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Abstract During radical cystectomy (RC), the neurovascular bundles are easily removed or damaged, leading to varying rates of incontinence and erectile dysfunction. The nerve-sparing technique was developed to preserve urinary and erectile function. The adoption of laparoscopic and robot-assisted technology has improved visualization and dexterity of pelvic surgeries, thus facilitate the nerve-sparing technique. Although nerve-sparing RC is technically similar with nerve-sparing radical prostatectomy, there are still some anatomical differences. There are mainly three different types of nerve-sparing techniques. Pelvic lymph node dissection (PLND) is another important factor to influence erectile function and urinary continence. Nerve-sparing laparoscopic radical cystectomy (LRC) and robot-assisted radical cystectomy (RARC) may be an optimal treatment choice in well-selected younger patients with low-volume, organ-confined disease. We should attempt to do, whenever possible, a nerve-sparing cystectomy at least on oneside. However, due to the need of a well-refined surgical technique, nerve-sparing LRC and RARC is now being performed only by experienced urological surgeons.

1. Introduction

Radical cystectomy (RC) with neobladder reconstruction still represents the first choice of treatment for both muscle-invasive and high-risk non-muscle invasive bladder cancer. In recent years, minimally invasive surgery such as laparoscopic radical cystectomy (LRC) and robot-assisted radical cystectomy (RARC) are performed more commonly at many centers with the technological advancements. The safety and

* Corresponding author.
E-mail address: urolhj@sina.com (J. Huang).
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potential advantages in terms of blood loss, analgesic requirements, improved cosmesis and quick recovery of LRC and RARC compared to open RC (ORC) have been well established [1—3]. At present, the ultimate goal of LRC and RARC is to remove the tumor completely while still maintaining erectile function and urinary continence at the same time.

During RC, particularly ORC, the neurovascular bundles are easily removed or damaged. Varying rates of continence and erectile function have been described after RC in the literatures as the degree of injury to the neurovascular bundles differed from technique to technique [4—6]. RC was then modified on the basis of this information to avoid injury to the neurovascular bundles and thus better preserve erectile function and urinary continence in patients undergoing this operation.

Although nerve-sparing RC has been proposed in the 1980s, progress of this procedure actually remained limited over the years [7]. However, nerve-sparing radical prostatectomy (RP), which is widely applied for more than 20 years, has achieved a consolidate position in routine clinical practice of every urologic unit [8]. Whether the nerve-sparing technique in prostatectomy could be applied in RC is still controversial. Firstly, the innervations of the neobladder after RC is different from original bladder after RP. Secondly, the voiding pressure of neobladder is much lower than original bladder as the former does not have detrusor muscle. In addition, the pelvic lymph node dissection (PLND) is much more extensive during RC than RP, thus higher branches of pelvic plexus may be injured. Moreover, as urothelial carcinoma is considered to be a potential lethal disease, nerve-sparing surgery may compromise the oncological safety.

Nevertheless, the adoption of laparoscopic and robot-assisted technology has improved visualization and dexterity of pelvic surgeries. Several studies with varying results after nerve-sparing LRC have been published [8—10]. Herein we review the current available literatures concerning the anatomic basis, nerve-sparing techniques, and therapeutic effects of nerve-sparing LRC and RARC in male patients. We aim to clarify the rational nerve-sparing techniques and establish the proper patient selection criteria.

2. Evidence acquisition

A literature search was performed in February 2016, using the PubMed and the Web of Science databases. The following terms and their combinations were searched in Title/Abstract: "nerve-sparing", "laparoscopic", "robot-assisted", "radical cystectomy" and "male". Case reports and non-English articles were excluded. Full text case series and their references were reviewed.

3. Evidence synthesis

3.1. New insights of the anatomical basis of nerve-sparing radical cystectomy

In 1982, Walsh and Donker [11] suggested that erectile dysfunction (ED) was caused by damage to the neurovascular bundles (NVB), which supply the corpora cavernosa. In 1983, Walsh et al. [12] found that the branches of pelvic nerve plexus which dominate corpora cavernosa locate laterally of the prostate capsule and Denonvillier's fascia. They spread along the post lateral part of the prostate and the urethra, the anterior wall of the rectum. These delicate nerves spread along with the blood vessels supplying prostate, seminal vesicle, bladder neck and urethra, and together they form the NVBs which are embedded in the dense fibrous connective fat tissue [12]. NVBs play an important role in erectile function and urinary control. By using cadaver models, Costello et al. [13] further detailed the precise anatomy of the NVBs because of their close relationship to the prostate and seminal vesicles. They identified three functional components of the NVBs. The first posterior and posterolateral component runs within Denonvillier's fascia and the pararectal fascia and innervates the rectum. The second lateral component supplies the levator ani. The third component cavernosal nerves and prostatic neurovascular supply, originally described by Walsh and colleagues [11,12], lie along the posterolateral surface.

Takenaka et al. [14] confirmed that branches of the hypogastric nerve and the pelvic splanchnic nerve are likely to interdigitate at multiple levels, showing spray-like arrangement without clear bundle formation. In addition, Lunacek et al. [15] demonstrated that during the growth of the prostate, the cavernous nerves running along the prostate are displaced more anteriorly and spread, thus forming a concave shape (like a "curtain") of the NVBs. Therefore, dissection of the NVBs has to start anteriorly to preserve all the nerve fibers that are spread along the surface of the lateral lobes of the prostate.

Although nerve-sparing RC is technically similar with nerve-sparing RP, there are still some anatomical differences. During RC, the lateral portion of each bladder vascular pedicle is stapled with a vascular staple load, and a second staple load is used to divide the proximal portion of the posterior pedicle. Clips and athermal dissection are used to divide the distal portion of the posterior pedicle, staying close to the seminal vesicles, thereby avoiding undue damage to the erectile nerves that are in close proximity lateral to the seminal vesicles [9,16]. In addition, a more extended PLND should be performed in RC compared with RP, and the erectile nerves are at risk of injury when the lymph nodes in the presacral and internal iliac area are being removed [17].

3.2. Different techniques of nerve-sparing radical cystectomy

There are mainly three different types of nerve-sparing techniques. Their main features and relative reports are described below (Table 1).

3.2.1. Nerve-sparing cysto-vesicle prostatectomy (NS-CVP)

This technique, adopted according to that initially described by Schlegel and Walsh [18] in 1987, includes the "en bloc" removal of bladder, prostate and seminal vesicles only leaving the NVBs intact. This is the most commonly used nerve-sparing procedure which was mainly carried out by a transperitoneal approach, using a combined ante-