A cadaveric demonstration of visualization of the urethra using a lighted stent during transanal intersphincteric resection

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Abstract

Urethral injury is one of the crucial intraoperative complications during transanal total mesorectal excision (taTME) for male patients with low rectal cancer. Urethral injury can occur during the anterior dissection around the inferior lobe of the prostate and the membranous urethra. A tool to visualize the urethra around this area would be useful to avoid urethral injury. We report a cadaveric demonstration of visualization of the urethra using a lighted stent during transanal intersphincteric resection. The lighted stent (InfraVision Ureteral Kit, Stryker) was placed through the irrigation channel of a clear three-way urinary catheter. After the anterior dissection, the visibility of the lighted stent was investigated under the three laparoscopic light conditions: (1) normal intensity; (2) low intensity; and (3) turned-off. In the proper dissection plane that led to preservation of the urethra, the lighted stent was hardly visible under the normal-intensity condition, but it was clearly visible under the turned-off condition. In the improper dissection plane that led to urethral injury, the lighted stent was clearly visible under both the normal-intensity and the turned-off conditions. Visualization of the urethra using the lighted stent under the turned-off condition of the laparoscopic light can be useful to avoid inadvertent urethral injury during the anterior dissection of male taTME. Clear visibility of the lighted stent under the normal-intensity condition can indicate that the dissection plane is too close to the urethra.

Keywords taTME · Urethral injury · Lighted stent · Urethral identification

Introduction

Transanal total mesorectal excision (taTME) is gradually spreading throughout the world as a novel approach for low rectal cancer. This approach is expected to improve clinical, oncological, and functional outcomes by providing better

visualization of the anal canal and enabling accurate TME [1]. However, the surgical view from the anal side is unfamiliar to surgeons, which can occasionally lead to misrecognition of the anatomical structures. In particular, urethral injury is one of the crucial intraoperative complications with this approach in male patients [2]. Urethral injury can occur around the inferior lobe of the prostate and the membranous urethra [3]. Therefore, real-time visualization of the urethra can be useful to avoid urethral injury during taTME.

In this video article, we present a cadaveric demonstration of visualization of the urethra using a lighted stent during transanal intersphincteric resection.

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Materials and methods

In this study, one male Thiel-embalmed cadaver [4] donated to the Department of Anatomy and Embryology, Ehime University Graduate School of Medicine, was used. Surgical training using cadavers was given ethical approval by the

same university. Thiel-embalmed cadavers have greater flexibility and color retention compared to formalin-embalmed cadavers; therefore, they are usually used for surgical training in Japan.

The cadaver was placed in the lithotomy position. A clear three-way urinary catheter (18 Fr) was introduced into the bladder. Taking clinical use into consideration, a lighted stent (InfraVision Ureteral Kit, Stryker, Inc. Kalamazoo, MI, USA) was placed through the irrigation channel of the urinary catheter to avoid interruption of the urinary flow and contact bleeding from the urethral and bladder walls (Fig. 1a–c). Since the light wavelength of the lighted stent is around 830 nm, the light is not visible under normal illumination. Thus, an infrared-detecting camera system (1588 AIM Platform, Stryker) was used in the present study.

Transanal intersphincteric resection was performed by a colorectal surgeon with experience performing over 30 taTME operations. The circumferential rectal incision and subsequent intersphincteric dissection were performed under direct vision. After closure of the anal orifice, a single port device (GelPOINT Mini, Applied Medical, Inc. Rancho Santa Margarita, CA, USA) was placed to start the transanal approach. During the posterior dissection of the rectum, the connective tissue covering the mesorectum was divided by electric cautery. After identification of the pelvic splanchnic nerves at the 5 and 7 o'clock positions, the dissection plane was extended to the anterolateral side of the rectum. The anterior dissection of the rectum was performed until

the posterior surface of the prostate was exposed under the normal-intensity condition of the laparoscopic light (Lap-L) with the source of the lighted stent on. Once the posterior surface of the prostate was identified, it was relatively easy to dissect at the boundary between the mesorectum and the neurovascular bundle.

After the proper dissection was completed, the visibility of the lighted stent was investigated under the three Lap-L conditions: (1) normal intensity; (2) low intensity; and (3) turned-off. Next, deeper dissection of the anterior side was intentionally performed to injure the urethra (improper dissection). After the improper dissection was performed, the visibility of the lighted stent was also investigated. Finally, the urethra was divided.

Results

During the anterior dissection, the lighted stent could not be identified under the normal-intensity condition.

After the proper dissection was performed, the lighted stent was hardly visible under the normal-intensity condition and barely visible under the low-intensity condition (Fig. 2a, b). However, the lighted stent was clearly visible under the turned-off condition (Fig. 2c). The lighted area was located between the inferior lobe of the prostate and the superior part of the membranous urethra. When the urinary catheter

Fig. 1 Setup of a lighted stent.

a, b A lighted stent is placed through the irrigation channel of a three-way urinary catheter. The stent is connected to the external infrared source generator. **c** A sectional schema of the urinary catheter. The irrigation channel is located at the edge (not center) of the urinary catheter

Fig. 2 Transanal view in the proper dissection plane. **a** Normal-intensity condition. The lighted stent is hardly visible. **b** Low-intensity condition. The lighted stent is barely visible. **c** Turned-off condition. The lighted stent is clearly visible

was rotated, the light intensity of the lighted stent varied depending on the angle of the urethral catheter.

After the improper dissection was performed, the lighted stent was clearly visible even under the normal-intensity condition. In addition, the lighted stent was more

clearly visible under the turned-off condition (Fig. 3a, b). The lighted area was the urethral wall. The tissues that intervened between the proper and improper dissection planes were very thin (Fig. 3c).

Fig. 3 Transanal view in the improper dissection plane. **a** Normal-intensity condition. The lighted stent is clearly visible. **b** Turned-off condition. The lighted stent is clearly visible. **c** The view after the urethra was intentionally divided. White arrowheads indicate the urinary catheter

Discussion

In the proper dissection plane, the lighted stent was hardly visible under the normal-intensity condition, but it was clearly visible under the turned-off condition. The lighted area was located between the inferior lobe of the prostate and the superior part of the membranous urethra. Use of the lighted stent under the turned-off condition can be useful to avoid inadvertent urethral injury during the anterior dissection of taTME, because the urethra is susceptible to injury in this area [3].

In the improper dissection plane, the lighted stent was clearly visible even under the normal-intensity condition. Namely, if the lighted stent is clearly visible under the normal-intensity condition, the dissection plane is too close to the urethra.

The lighted stent was designed to illuminate through up to 12 mm of tissue. In this study, it was confirmed that the tissues that intervened between the proper and improper dissection planes were very thin, although the thickness of the tissues was not measured. However, the intensity of light passing through this thin tissue from the lighted stent was varied greatly, which indicates that slightly deeper dissection of the anterior side can easily lead to urethral injury.

In this study, the lighted stent was placed into the irrigation channel of the three-way urinary catheter. Since the irrigation channel is located at the edge (not center) of the three-way urinary catheter (Fig. 1c), the light intensity of the lighted stent varied depending on the rotation angle of the urinary catheter. Taken together, the light intensity of the lighted stent can be changed by factors such as the intervening tissues, the intensity conditions of Lap-L, and the distance between the lighted stent and the tip of the Lap-L. Atallah et al. reported that one or two lighted stents were placed through the main channel of a two-way urinary catheter for visualization of the urethra [5, 6]. Although high and stable light intensity is likely to be obtained by their method, the lighted stent may interrupt the urinary flow and cause urinary tract infection.

There are two limitations in this study. One is that only one cadaver was examined. The light intensity of the lighted stent may be different from that in clinical patients because of postmortem changes and embalmment. The other is the subjective estimation of the light intensity of the lighted

stent. The light intensity can differ depending on the operator under the normal- or the low-intensity condition. However, since the lighted stent was clearly visible under the turned-off condition (Figs. 2c, 3b), this lighted stent can be a useful tool to avoid urethral injury. We plan to start a clinical trial to investigate the usefulness of the lighted stent during taTME.

Conclusion

Visualization of the urethra using the lighted stent under the turned-off condition of the laparoscopic light can be useful to avoid inadvertent urethral injury during anterior dissection in male taTME.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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